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FURTHER STUDIES ON TRANSMISSION OF BUNCHY-TOP AND MOSAIC OF ABACÁ (MANILA HEMP PLANT), SEPARATION OF THE TWO DISEASES, AND MECHANICS OF INOCULATION BY PENTALONIA NIGRONERVOSA COQUEREL[1]

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and Feliciano J. Garcia
Of the Department of Plant Pathology

WITH TWO TEXT FIGURES

BUNCHY-TOP OF ABACÁ

Bunchy-top of abacá, or Manila hemp, in the Philippines (Ocfemia, 1926, 1930) and bunchy-top of banana in Australia (Magee, 1927) are apparently caused by two different viruses transmitted by the same insect vector, *Pentalonia nigronervosa* Coquerel. Ocfemia and Buhay (1934) differentiated between the two diseases as follows: Bunchy-top in the Philippines (*Marmor abacá* Holmes [1930]) is restricted to abacá and does not infect bananas and plantains, including *Musa cavendishii* Lam, in nature or in transmission experiments; and in serious cases of infection of abacá with the disease, from 11 to 17 per cent of the infected plants develop heart rot (Ocfemia, 1927). Furthermore, the virus of bunchy-top of abacá requires an incubation period of 24 to 48 hours in *Pentalonia nigronervosa* before it can cause infection. Bunchy-top in Australia (*Marmor cucumeris* Holmes), on the other hand, is primarily a banana disease, although Magee (1927) reports that it also infects abacá and wild seedy species of *Musa*.

MOSAIC DISEASE OF ABACÁ

In 1930, Magee reported on infectious chlorosis, a new virus disease of bananas in New South Wales, which, according to him, is a type of mosaic that can be transmitted also by *Pentalonia nigronervosa*. In 1940, however, he was able to confirm the transmission of the banana mosaic by *Pentalonia nigronervosa* only with difficulty. He concluded that *P. nigronervosa* is an unsteady vector of the infectious chlorosis of banana and therefore probably of no importance in the field.

In 1937, the senior writer noted that almost 50 per cent of the abacá in the different plantations in Davao had mosaic (*Marmor cucumeris*

[1]Experiment Station contribution No. 1464.
[2]Formerly instructor in plant pathology; resigned October 16, 1941.

Holmes var. *commelinae* Holmes). Ocfemia and Celino (1938) succeeded in transmitting the disease with *Aphis gossypii* Glover and two other aphids. In 1940, Celino reported transmission of the mosaic disease of abacá with *Rhopalosiphum nymphae* (Linné) and *Aphis gossypii* and the failure of transmission by *Pentalonia nigronervosa, Ferrisia virgata* (Cockerell), and *Stephanitis typica* (Distant). In 1941, Celino and Ocfemia found that in addition to *Aphis gossypii* and *Rhopalosiphum nymphae*, another species of *Rhopalosiphum*, probably *R. prunifoliae* Fitch, and *Aphis maidis* Fitch could transmit abacá mosaic to abacá and corn, but *Aphis laburni* Kaltenbach and *Pentalonia nigronervosa* could not. Furthermore, *Aphis maidis* could recover the virus from corn and transmit it again to abacá and corn.

Abacá mosaic can be readily recognized by the mottling of the leaves, petioles, green portions of the leaf sheaths and flower bracts. It resembles very closely the infectious chlorosis, or mosaic, of banana in Australia. Abacá plants which showed symptoms of both bunchy-top and mosaic were noted in Davao, Mindanao, in 1937, and in the experimental plots of the Department of Plant Pathology at Los Baños in 1939 and 1940. The occurrence of the mixed infections seems to show that the presence in the abacá plants of one of the viruses does not protect abacá from the other virus. In order to determine how readily abacá plants infected with one virus may be infected with the other, reciprocal transmission experiments were conducted.

TRANSMISSION OF BUNCHY-TOP TO MOSAICKED ABACÁ

Experiment 1. On July 29, 1940, fifty adult individuals of *Pentalonia nigronervosa* which had been allowed to feed on an abacá plant infected with bunchy-top were transferred to each of four mosaicked abacá seedlings. The experimental plants were bagged and the aphids were allowed to feed for 10 days. Two other mosaicked plants with aphids from healthy abacá served as control.

Of the four experimental plants, three developed bunchy-top in 33 to 53 days and one in 62 days. The control plants did not show infection with bunchy-top even at the end of the experiment.

Experiment 2. On December 7, 1940, five mosaicked abacá plants were used for colonizing the same number of *Pentalonia nigronervosa* from a bunchy-topped abacá. The aphids were also left on the experimental plants for 10 days. Check plants were provided as in Experiment 1.

All of the experimental plants showed symptoms of bunchy-top in 34 to 45 days (fig. 1).

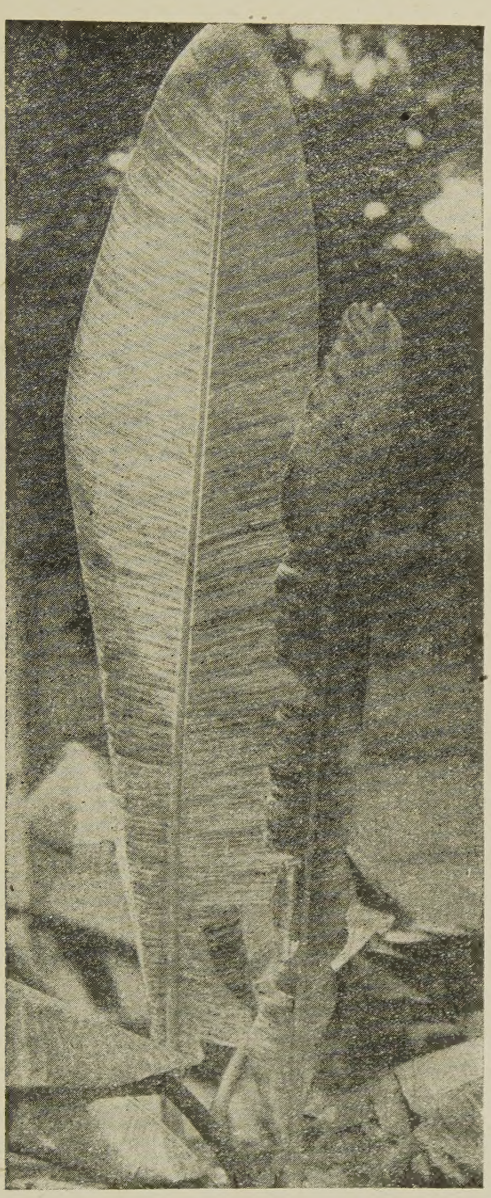

Fig. 1.—The youngest expanded leaves of two abacá plants from a mosaic-infected stool. The plants were of about the same age and the expanded leaves were in about the same stage of development. The plant in the foreground was infected with bunchy-top in the transmission experiment using *Pentalonia nigronervosa* Coq. as vector. Note its shortened and narrowed leaf with curled up margins. Note also that except for the numerous yellow stripes, the leaf of the abacá infected with mosaic alone showed no appreciable change of shape and size. Photographed by the Photographic Division, College of Agriculture.

The results of the experiments indicate that mosaicked abacá plants may be infected readily with bunchy-top.

TRANSMISSION OF MOSAIC TO BUNCHY-TOPPED ABACÁ

Experiment 1. On January 14, 1941, fifty adult individuals of *Aphis gossypii* which had been allowed to feed on a mosaicked abacá for some time were transferred to each of three abacá plants infected with bunchy-top. The experimental plants were bagged and the aphids were killed with Black Leaf 40 solution after 10 days. Checks, consisting of two bunchy-topped abacá plants with *Aphis gossypii* taken from healthy abacá, were provided.

Of the three plants used, two showed mosaic symptoms in 13 days and one in 16 days. No infection with mosaic was noted on the check plants.

Experiment 2. On January 31, 1941, four bunchy-topped abacá plants were used for colonizing adult individuals of *A. gossypii* taken from a mosaicked abacá. Two other plants infected with bunchy-top and with aphids from healthy abacá plants served as control.

All four plants showed mosaic after a period of incubation ranging from 14 to 21 days.

The results of these two experiments indicate that abacá plants infected with bunchy-top may be more readily infected with mosaic than a mosaicked abacá with bunchy-top. It was also noted that if the bunchy-top infected abacá first, the mottling was less conspicuous than when healthy abacá was infected with the disease. Furthermore, the effects of bunchy-top on abacá were more marked than those of mosaic. The leaves became progressively smaller and were often distorted.

SEPARATION OF MOSAIC AND BUNCHY-TOP FROM ABACÁ PLANTS INFECTED WITH BOTH DISEASES

The abacá plants infected with mosaic and bunchy-top were used to determine whether or not the two diseases could be transmitted separately to healthy abacá plants.

Experiment 1. On October 20, 1940, five four-month-old healthy abacá plants raised from seeds were selected for colonizing on each plant 50 adult individuals of *Pentalonia nigronervosa* taken from abacá plants infected with mosaic and bunchy-top. The plants were bagged and the aphids were left on the plants until symptoms of infection appeared.

The first symptom of bunchy-top was noted on the furled and newly expanded leaves of the experimental plants in 24 to 43 days. These leaves appeared slightly reduced in size, were chlorotic along the margin, and showed characteristic transparent or clear veins when viewed by trans-

mitted light. Later, the infected plants showed stunting and a rosette-like formation of the leaves on the upper portion of the pseudostems. Although all of the experimental plants became infected with bunchy-top none of them showed symptoms of the mosaic disease.

Experiment 2. From November 1 to 20, 1940, fifty adult individuals of *P. nigronervosa* were transferred to each of 12 healthy abacá seedlings. Of these plants 8 showed bunchy-top in 20 to 50 days. In no instance, however, was mosaic manifested by any of the experimental plants.

Experiment 3. On November 22, 1940, three healthy abacá seedlings were used for colonizing adults of *Aphis gossypii* which had fed overnight on the source of inoculum. Fifty virus-laden aphids were transferred to each seedling. The plants were bagged and kept on benches outside the laboratory.

All of the plants showed mosaic in less than two weeks; the period of incubation varied from 7 to 13 days. No symptom of bunchy-top was shown by any of the plants even after two months.

Experiment 4. On January 11 and 18, 1941, fifty adults of *Aphis gossypii* were transferred to each of four abacá seedlings. Although all four plants became mosaicked none of them showed bunchy-top.

The results of these experiments indicate that when abacá plants are infected with bunchy-top and mosaic, either of the viruses may be transmitted independently of the other, depending upon whether *Pentalonia nigronervosa* or *Aphis gossypii* is used. Neither of these two aphids will transmit both viruses. Again, it may be noted in these experiments that the incubation period of the mosaic is shorter than that of bunchy-top.

MECHANICS OF INOCULATION WITH BUNCHY-TOP BY PENTALONIA NIGRONERVOSA

The method of penetration of abacá leaves by the stylets of *Pentalonia nigronervosa* was studied. Cross sections of abacá leaves with feeding aphids were prepared. Small portions of abacá leaves with *P. nigronervosa* on them were carefully cut without disturbing the insects. The sections were quickly but carefully placed in a vial containing a piece of cotton moistened with chloroform and there allowed to remain for about one minute. This work was done on cool days or in the morning while the aphids were actively feeding. After the chloroform treatment, the leaf sections were trimmed off to the desired size and then fixed in Chamberlain's (1932) formo-aceto alcohol for four days, washed with water, passed through the usual grades of alcohol, embedded in paraffin, and cut into sections 15 to 20 microns thick. Chamberlain's formo-aceto alcohol was modified by using 90 cc. instead of 85 cc. of 70 per cent alcohol, and 5 cc. instead

of 10 cc. of commercial formalin. The sections were stained overnight with safranin A prepared by dissolving 1.0 gram safranin in 50 cc. of 95 per cent ethyl alcohol and diluting with 50 cc. of distilled water. The sections were counterstained with gentian violet prepared by dissolving 1.0 gram of gentian violet in 20 cc. of 95 per cent ethyl alcohol and 80 cc. of water and then adding 3.0 cc. of aniline.

Examination of the prepared slides showed that the stylets of *P. nigronervosa* (fig. 2) pierced the abacá leaf from the nether surface. After

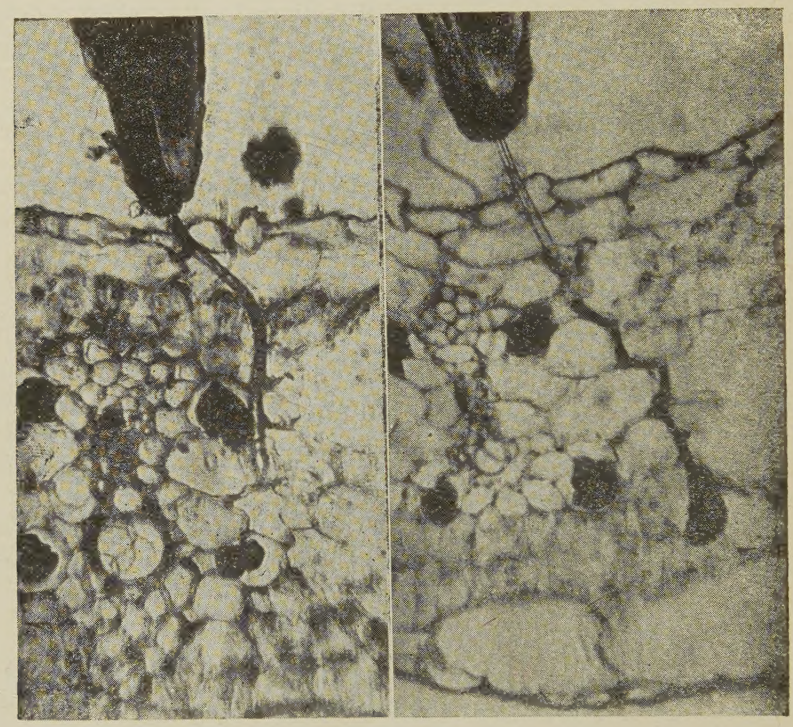

Fig. 2.—Photomicrographs of cross sections of an abacá leaf showing the positions of the proboscis of *Pentalonia nigronervosa* Coq. in relation to the host cells. In both figures the probosces are between the cells with the tips in the immediate vicinity of the vascular bundles. About × 400. Photomicrographed by the Photographic Division, College of Agriculture.

penetration the stylets traveled in the direction of the phloem. When the stylets had penetrated the leaves at some distance from the region of the phloem, the tips of the stylets curved in the direction of the phloem. This evident preference for the phloem tissue has been reported by earlier workers: Büsgen (1891), Brandes (1923), Davidson (1923), Horsfall (1923), Smith (1933), Bennett (1934), and Tate (1937).

As a rule the stylets entered the leaf by direct penetration and reached the phloem by passing between the cells. Tate (1937), in his study of the method of penetration of 15 species of aphids on 19 species of plants, noted three types of setal paths. Some setae traveled intercellularly to the vascular bundle, others intracellularly, and still others directly to the vascular bundle regardless of cells or intercellular spaces. He noted further that in all aphids he studied, the vascular bundle, particularly the phloem tissues, was the objective of the setae. Occasionally, the stylets of *P. nigronervosa* passed through some of the cells on their way to the phloem. During penetration, salivary material formed a coating or sheath around the stylets, which sheath appeared reddish when stained with safranin A and counterstained with gentian violet.

According to Tate (1937), during the penetration and the feeding processes of aphids the piercing organ is enveloped by saliva injected by the insect and by plant juices from the injured tissues. Owing to the action of the saliva, there is precipitation or coagulation of substances with formation around the setae of a thin-walled tube referred to as the stylet sheath. Tate (1937) further states that the function, chemical and physical composition, and the chemical reactions which take place during the formation of the setal sheath are not perfectly understood.

In his study of the sheath material in the feeding punctures of *Empoasca favae* (Harris), Cicadellidae, Homoptera, and *Stictocephala festina* (Say.), Membracidae, Homoptera, Smith (1933) found that the sheath comes from the insect and does not contain plant substance, with the possible exception of pectose. The plant injuries caused by the feeding of these two leaf hoppers are due to the highly insoluble sheath which persists in the vascular tissue and probably interferes with the normal translocation of plant materials. It has been suggested by some authors (Brandes, 1923) that the salivary secretions of the aphid act as the medium by which the virus is conveyed to the host plants.

TRANSMISSION OF BUNCHY-TOP THROUGH THE ROOTS OF ABACÁ SEEDLINGS[3]

Practically all studies on insect transmission of virus diseases have been carried out on parts of the plant above the ground, that is, on stems and leaves. In the writer's earlier work on bunchy-top of abacá (Ocfemia, 1930) it was noted that during the dry season and immediately after heavy rains, *Pentalonia nigronervosa* was present on the roots and on the corms of abacá. To determine whether transmission of bunchy-top may be effected through the exposed tender roots of abacá, experiments were per-

[3] Taken from the thesis of Feliciano J. Garcia submitted April, 1947, for graduation with the degree of Bachelor of Science in Agriculture.

formed on roots of abacá seedlings. The roots were carefully washed under faucet, care being taken not to destroy them. The seedlings with the aphids on the proximal ends of the roots were each inserted into 300-cc. Erlenmeyer flasks half filled with tap water. The corms of the seedlings were loosely wrapped in cotton to fit the mouths of the flasks and to hold the plants in place and at the same time prevent the aphids from going up to the corms and pseudostems. The aphids were confined to the proximal ends of the roots above the water.

After feeding on the roots for a few days, the aphids were destroyed with a soap solution and tobacco decoction. The seedlings were each planted in a gallon can of sterilized soil, covered with cheesecloth, placed on an antproof stand, and observed for the appearance of symptoms of infection.

Experiment 1. On December 14, 1946, twenty-five adult individuals of *Pentalonia nigronervosa* Coq. which had fed for four days on a bunchy-topped abacá plant were transferred to the roots of each of ten abacá seedlings and allowed to feed for six days. Non-viruliferous *Pentalonia nigronervosa* were transferred to the roots of a seedling for check.

On January 20, 1947, one of the seedlings showed symptoms of infection. On January 26, another seedling became infected. The rest of the seedlings, including the check, remained healthy.

Experiment 2. On December 19, 1946, twenty-five adults of *Pentalonia nigronervosa* which had been confined on diseased abacá for four days were transferred to each of ten abacá seedlings which were three months and twenty-one days old and allowed to feed for five days on the experimental seedlings. One seedling was used as check.

On January 31, 1947, one of the seedlings showed symptoms of infection, whereas the rest, including the check, remained healthy.

Experiment 3. On December 28, 1946, twenty-five *Pentalonia nigronervosa* which had been allowed to feed on a bunchy-top abacá plant for five days were transferred to the roots of each of ten 122-day-old abacá seedlings and allowed to remain there for six days. Twenty-five non-viruliferous *Pentalonia nigronervosa* were transferred to each of the remaining five seedlings for check.

After 29 days, one of the seedlings showed typical symptoms of bunchy-top, but the rest and the check were healthy.

The results of the experiments on transmission of bunchy-top by *Pentalonia nigronervosa* through the roots of abacá show that under field conditions very little, if any, communication of the virus from diseased to healthy plants probably takes place even through the young and tender

roots. In the laboratory, however, the vector was forced to feed on the roots because it was confined on them. The transmission of abacá bunchy-top through the roots of some of the seedlings by *Pentalonia nigronervosa* probably took place only where the aphids were able to penetrate the epidermal system directly with their setae. On parts above the ground, penetration of the tissues of plants by aphids may have been directly through the cuticularized epidermis or through the stomata. According to Davidson (1923), aphids penetrate the tissues of plants "by means of a flexible, chitinous, piercing organ, which is composed of the maxillary stylets and the mandibles. The maxillary stylets are closely apposed, thus forming two canals, which extend to the extremity of the compound stylet thus formed. The dorsal canal is the suction canal along which the plant juices are conducted into the pharynx. The ventral canal is the ejector salivary canal down which the saliva is pumped into the plant. The penetration of the piercing organ is brought about by the retraction of the labium and the forward prolongation of the 'forehead.' The labium at its distal end grips the piercing organ in a pincer-like manner. . . . The saliva is able to dissolve a passage for the piercing organ through the walls of the cells. . . ."

Horsfall (1923) reports that aphids pierce the epidermis, the parenchyma, and the phloem vessels, and, in a few cases, the setae can pierce the tracheal tubes. The writers noted both direct and stomatal penetration of abacá leaves with the setae of *Pentalonia nigronervosa*.

SUMMARY

1. Abacá may be readily infected with bunchy-top and mosaic, the presence of which two diseases in the same plant can easily be recognized.

2. If abacá is infected with bunchy-top and mosaic, the virus of bunchy-top may be drawn and transmitted to healthy abacá by *Pentalonia nigronervosa;* and the virus of the mosaic disease, by the vectors of the mosaic disease. *Pentalonia nigronervosa* cannot transmit abacá mosaic; neither can the vectors of the abacá mosaic transmit bunchy-top of abacá.

3. The vector of bunchy-top, *Pentalonia nigronervosa,* inserts its stylet either through the stomata or directly through the epidermis and pierces the tissue either intercellularly or intracellularly on its way to the phloem element. The sheath formed around the stylet appears reddish when stained with safranin A and counterstained with gentian violet.

4. *Pentalonia nigronervosa* can transmit bunchy-top through the roots of abacá seedlings. The incubation period in transmission through the roots is longer than that in transmission through the pseudostems and

leaves. Transmission through the roots under field conditions probably rarely takes place if ever.

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MORPHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF DEAWNING ON CARYOPSIS OF TWO BEARDED RICE VARIETIES[1]

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WITH THREE TEXT FIGURES

The present experiments were conducted with a view to discovering facts and gathering information on the effects of removing awns (deawning) on bearded rice varieties.

The work was performed in the experimental paddies and in the Plant Genetics laboratory of the Department of Agricultural Botany, College of Agriculture, Los Baños, Laguna, from December, 1945, to January, 1947.

MATERIALS AND METHODS

Varieties used

The bearded varieties used in this experiment were glutinous Bolilising and nonglutinous Binuntiek, both typical lowland rice. The seeds, which were obtained from a rice farmer in Cabanatuan, Nueva Ecija, were selected from his crop of 1945.

Method of planting

Preparation of seedbeds. Two seedbeds measuring 500 sq. m. and located near a ditch where water was available for irrigation any time of the day were prepared, one for the glutinous and the other for the nonglutinous rice. Farm manures were added to the soil to increase the plant nutrients and to improve the texture of the soil. The soil was saturated with water. On June 4, 1946, two liters of rice seeds of each variety contained in cloth bags were soaked in running water for 24 hours. Then the bags were placed in the shade for another 24 hours for incubation. On June 6, 1946, the seeds were broadcast in the beds and were watered morning and afternoon for five consecutive days. Then enough water to saturate the soil was supplied for one week.

Transplanting. To soften the soil, enough water was let into the seedbeds, and on July 5, 1946, or exactly 30 days after broadcasting, the seed-

[1]Experiment Station contribution No. 1465. Based on a thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture.

lings were pulled up and pruned, about one-third of the leaves being removed to minimize transpiration. The young plants were planted 20 cm. apart each way in irrigated paddies. One week after the transplanting, enough water was maintained in the paddies to simulate the conditions in ordinary lowland rice culture. The plants were taken good care of until they reached maturity.

Method of labeling

Two proximate culms from the same or different plants which seemed to be similar in appearance were selected at random at or before the booting stage. One of the culms was tagged control and the other experimental, so that for each experimental culm there was a control.

The following symbols were used to designate the experimental plants:

PBB — partially deawned one week before blooming
PB — partially deawned at blooming time
PI-B — partially deawned one week after blooming
TBB — totally deawned one week before blooming
TB — totally deawned at blooming time
TI-B — totally deawned one week after blooming
A plain tag was attached to the control plants.

The 100 tagged culms occupied only a small portion of the paddy. They were close to one another and were called a set. Six sets of a given variety being tagged, 12 sets or 1,200 culms for the two varieties were tagged.

Technique of deawning

A pair of scissors was used to remove the awn at the apex of the lemma, care being taken not to injure the lemma. The beak of the outer glume was removed at the same time as the awn.

The plants from which all the awns were removed were designated as *totally deawned*, and those from which the awns were removed from one side of the panicle were called *partially deawned* (fig. 1).

The panicles were deawned in three stages: namely, (*a*) a week before blooming, one half of the panicle still enclosed in leaf sheath, (*b*) at blooming, panicle out, but florets in anthesis and dehiscence, and (*c*) one week after blooming, whole panicle out and fertilization probably already accomplished.

The deawning of each variety at three different periods was both partial and total; hence, a total of six experiments were performed for each variety.

Fig. 1.—Samples of the control, partially deawned, and totally deawned panicles of rice. (*1*) Typical awned panicle (control); (*2*) partially deawned panicle; and (*3*) totally deawned panicle.

Harvesting

Each plant was individually harvested when it was mature. The culm was cut about 30 centimeters from the ground with a "panggapas" or scythe. The panicles were dried gradually by hanging them on the drying rack. Both varieties were treated in the same manner before they were threshed.

Threshing

Each panicle from both experimental and control heads was threshed separately by hand in order to prevent losing even a single grain. The awns from the control spikes were removed by clipping. Then the grains were carefully sorted into filled and empty grains.

Counting and weighing

All filled grains were carefully counted and weighed on a single-beam trip balance to the accuracy of a tenth of a gram. They were separately kept in envelopes on which the corresponding number of grains and weight in grams were noted.

The empty grains from individual panicles were weighed and placed in separate envelopes where the corresponding weights were also indicated.

RESULTS AND DISCUSSION

Effect of deawning on the weight of grains from 50 panicles

The highest percentage of decrease in weight of the grain was obtained from panicles deawned at blooming stage, and the lowest from those deawned one week after blooming. This result agrees fundamentally with that obtained in wheat by Miller, Gauch, and Gries,[2] although the decrease in the weight of grain was usually greatest when the panicles were deawned before blooming; and the effects of deawning tended to be less and less as the length of time following the deawning increased. In other words, in rice there was a maximum decrease in weight of grain when deawned at blooming, whereas in wheat this decrease was observed to be highest a week before blooming. The average percentage decrease of both varieties in the weight of the grain obtained from 50 panicles in all stages of deawning was very marked. The decrease in weight of partially deawned panicles, compared with that of totally deawned panicles in all stages, is approximately 50 per cent. This result is probably covered by the explanation given by Harlan and Anthony[3] that the kernels in clipped spikes developed as rapidly as those in the normal spikes for several days after the awns were removed.

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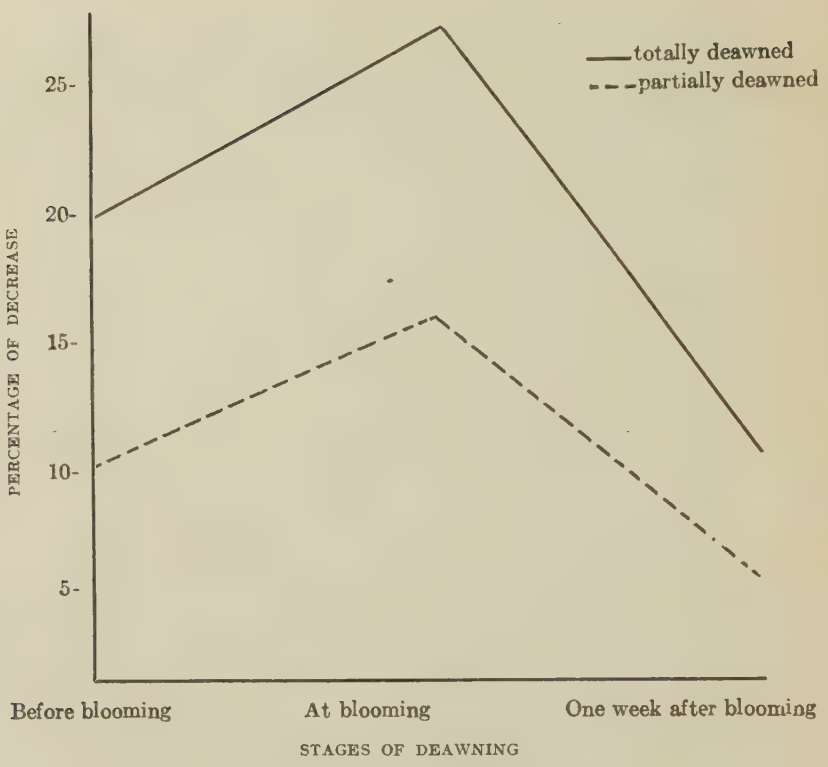

Fig. 2.—Percentage of decrease in weight of grains from 50 panicles.

Figure 2 presents graphically the distribution of the average decreases in percentage of the weight of grain of the two varieties. The average percentage decrease in the weight of grain from totally deawned panicles varied markedly from that from partially deawned panicles. Thus, the average decreases in the percentage of grain from the totally deawned panicles were 19.06 per cent when deawned one week before blooming, 25.43 per cent at blooming, and 11.40 per cent one week after blooming. In the case of partially deawned panicles, the corresponding average percentages of decrease were 9.88 per cent for those deawned one week before blooming, 13.67 per cent for those deawned at blooming time, and 4.99 per cent for those deawned one week after blooming.

Effect of deawning on the weight of 100 grains

Among the three stages of deawning, the decrease in the weight of grain was greatest at the time of blooming, less at one week before blooming, and least at one week after blooming. The trend of decrease in the

weight of grain observed during the three stages was similar in the two varieties studied. The average percentage decreases in the weight of grain when totally deawned were 13.65 per cent at one week before blooming, 21.40 per cent at blooming, and 8.39 per cent one week after blooming; while in partially deawned grains the decreases were 6.93 per cent at one week before blooming, 15.66 per cent at blooming stage, and 5.40 per cent at one week after blooming. Total deawning seemed to have reduced the weights of grain more than partial deawning.

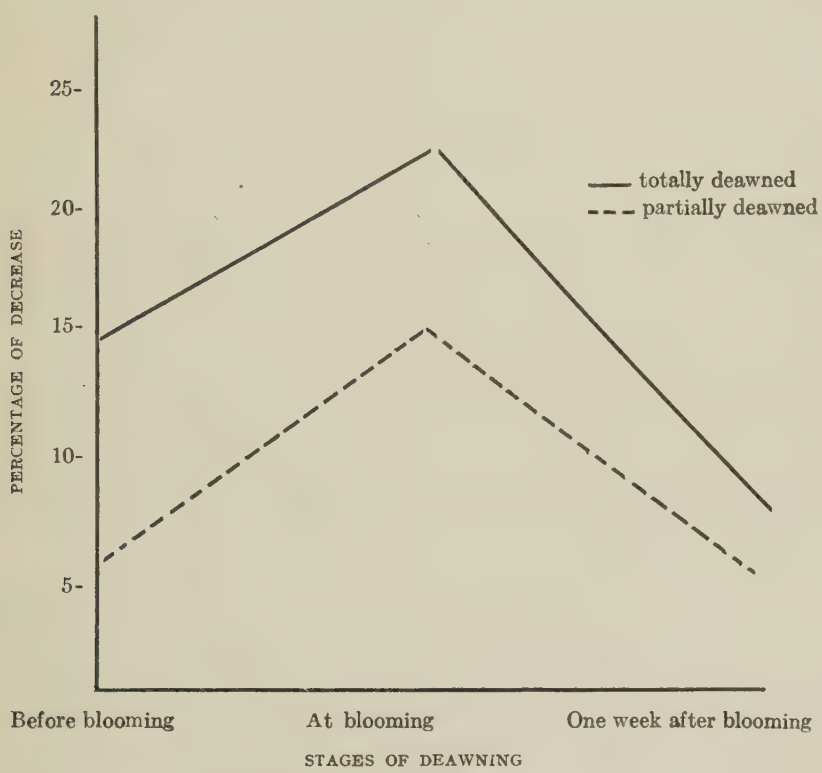

Fig. 3. —Percentage of decrease in weight of 100 grains.

Figure 3 shows that the 100 grains from totally deawned panicles had a greater loss in weight than the 100 grains from partially deawned panicles. The highest percentage decrease in weight was obtained from deawning at blooming stage of both varieties. In general, there was similarity in the trend of percentage of decrease in weight of the panicle and the grain when represented graphically.

Effect of deawning in 50 panicles

The mean number of filled grains produced by 50 deawned panicles in each of the three different stages of deawning was compared with the mean number of filled grains from the same number of control panicles. It was noted that in all cases of deawning the number of grains produced from totally or partially deawned panicles was smaller than that produced by the panicles whose awns were not cut. For those deawned at blooming stage, the mean difference between the number of filled grains produced as influenced by total deawning and the number of grains produced as influenced by partial deawning was significant. The number of filled grains produced from the deawned panicles was variable, that produced by panicles totally deawned one week before blooming being the most variable.

The mean number of empty grains produced by panicles of Bolilising deawned at different stages was compared with the mean number of empty grains from the control panicles. With one exception, the number of empty grains produced in the deawned panicles in both total and partial deawnings was significantly increased. The exception occurred in partial deawning at blooming stage and shows that deawning at this stage neither increased nor decreased the yield of empty grains.

The highest mean in the yield of empty grains obtained from the different deawned panicles was observed in totally deawned panicles one week before blooming. This yield was 35.3 $\mp$ 1.247. In partially deawned panicles one week after blooming, the yield of empty grains was 42.9 $\mp$ 1.301. The cause of the greater yield of empty grains in partial deawning than in total deawning is not known.

The number of empty grains obtained from both cases of deawning was also found to be variable. The number of empty grains produced by partially deawned panicles one week before blooming was the most variable as shown by the coefficient of variation of 30.57 $\mp$ 3.057 per cent. The least variable result was obtained from totally deawned panicles at blooming stage, their coefficient of variation being 14.46 $\mp$ 1.446 per cent.

The mean number of filled grains produced by different sets of deawned panicles revealed that in all cases of deawning the panicles which were totally deawned produced fewer filled grains than those which were partially deawned. In both cases of deawning, the experimental plants gave a comparatively low yield of filled grains per panicle. Where the panicles were partially deawned at blooming stage, however, the difference between the yield of filled grains and that of the control was insignificant. The greatest mean number of filled grains produced was 132.9 $\mp$ 1.753 and was

obtained from partially deawned panicles at blooming stage. On the other hand, the highest yield was obtained from the control, with a mean of 141.5 ∓ 1.813.

The experimental or deawned panicles gave much more variable yields in the number of filled grains than the control. It was found, however, that the difference between the yield obtained from totally deawned panicles one week after blooming and that obtained from the control panicles was insignificant.

The data on empty grains obtained from panicles of the nonglutinous variety Binuntiek deawned at different stages showed that, with two exceptions, the mean number of empty grains produced by the totally and partially deawned panicles was greater than that produced by the control. These two exceptions were obtained from the totally and partially deawned panicles one week after blooming.

The increases in the number of empty grains produced by total and partial deawning over the corresponding control were similar in the various stages when deawning was made.

Effect of deawning on percentage of ash in grain

The results of the ash analysis[4] based on moisture-free rice grains are presented in table 1 for the glutinous variety (Bolilising) and in table 2 for the nonglutinous variety (Binuntiek).

The data in these tables reveal the fact that the mean percentage of ash content was affected by deawning. Table 1 shows that the ash content of the grains of the glutinous variety decreased apparently as a result of deawning, while the ash content of the grains of the nonglutinous variety appear to have been increased by deawning (table 2).

The mean percentage of ash in the glutinous variety (Bolilising) was 7.71 per cent and in the nonglutinous variety (Binuntiek), 7.21 per cent. The maximum decrease in the percentage of ash content of grains was found to be statistically significant for the glutinous variety (Bolilising). Such decrease was obtained when the panicles were either partially deawned one week after blooming, or totally deawned one week before blooming. Likewise, the highest increase in the percentage of the ash content was obtained in the nonglutinous variety (Binuntiek) at the same stages of deawning. These findings on the effect of deawning on the percentage of ash are at variance with the results obtained by Miller, Gauch, and Gries,[5]

[4] The analysis of ash was made by the Department of Agricultural Chemistry, College, Laguna.

[5] Miller *et al.*, *op. cit.*

who reported that there was neither increase nor decrease of ash in wheat for either the partially or the totally deawned panicles.

The present results reveal that in the glutinous variety (Bolilising), deawning decreased the percentage of ash in grains. On the other hand, in the nonglutinous variety (Binuntiek), deawning increased the percentage of ash. The increase or decrease in percentage of ash in grain due to deawning referred to above would be statistically significant when compared with the control.

SUMMARY AND CONCLUSION

1. Total and partial deawning generally decreased the weight of grains produced in the panicle. The decrease in weight of the grain was greatest when the panicles were deawned at blooming stage.

2. The greatest variation in loss of weight occurred when deawning was performed either at the blooming stage or one week after blooming.

3. The weight of the partially deawned panicles was greater than the weight of the totally deawned panicles, the difference being approximately 50 per cent.

4. Total and partial deawning generally resulted in fewer filled grains.

5. Deawning of panicles influenced the production of a relatively greater number of empty grains.

6. Deawning led to a significant decrease in the percentage of ash content in the grains of the glutinous variety (Bolilising), while a significant increase was observed in the ash content of the nonglutinous variety (Binuntiek). This effect on ash content was shown in partial deawning one week after blooming, and in total deawning one week before blooming.

TABLE 1

Percentage of ash content of the glutinous variety (Bolilising)

TYPE OF GRAIN	SAMPLE			MEAN [a]
	1	2	3	
Control	7.45	7.55	8.13	7.71
PBB	7.49	6.95	6.96	7.13
PB	6.77	7.62	7.41	7.27
PI-B	6.11	6.35	6.20	6.22
TBB	6.31	6.39	6.45	6.38
TB	7.74	7.51	7.43	7.56
TI-B	6.97	7.20	7.37	7.18

[a] L.S.M.D. = 0.33

Analysis of variance

SOURCES OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					F.05	F.01
Type	6	5.6430	0.9605	27.9	2.85	4.46
Sampling	2	0.0894	0.0447			
Error	12	0.4173	0.0344			
Total	20	6.2497				

TABLE 2

Percentage of ash content of the nonglutinous variety (Binuntiek)

TYPE OF GRAIN	SAMPLE			MEAN [a]
	1	2	3	
Control	6.86	7.49	7.28	7.21
PBB	7.55	7.69	7.77	7.67
PB	7.06	7.16	7.55	7.26
PI-B	8.63	8.11	8.21	8.32
TBB	8.63	8.47	8.15	8.42
TB	7.55	7.54	7.88	7.66
TI-B	8.35	8.07	8.12	8.18

[a] L.S.M.D. = 0.44

Analysis of variance

SOURCES OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F	TABULAR VALUE	
					F.05	F.01
Type	6	4.41	0.735	11.8	3.00	4.82
Sampling	2	0.01	0.005			
Error	12	0.74	0.062			
Total	20	5.16				

BREEDING HABITS OF SHEEP[1]

CONSTANTE A. LUNA

The raising of sheep in the Philippines although not carried on a large scale is important. Besides furnishing mutton and wool, sheep give important by-products, such as: hides used in the manufacture of parchment, gloves, drums, and mandolins; internal organs made into fertilizers; and bones for bone meal. Forages in orchards and coconut groves may be utilized for their feed. The manure which is scattered in the fields serves to enrich the soil. The wool, which is used mainly for stuffing purposes, is more durable than vegetable fiber.

In sheep raising the breeder should know the breeding habits of sheep to obtain greater efficiency in increasing the reproductive capacity of his animals. A study was made in the Department of Animal Husbandry from April, 1943, to June, 1944, with the object of determining the following breeding habits in ewes: (*a*) signs of oestrus, (*b*) duration of oestrus, (*c*) recurrence of oestrus, (*d*) interval between parturition and the next oestrual period, (*e*) age at first oestrus, (*f*) signs of pregnancy and approaching parturition, (*g*) gestation period, (*h*) behavior of the ram and the ewe at breeding time, and (*i*) duration of labor.

Review of literature

Observations on the breeding habits of sheep have been made by various authors. In regard to oestrus, Winters (1925) states that it is manifested by an increase in the size of the mammary glands of ewes not nursing young, flow of heat mucous, which resembles the white of an egg, from the glands lining the vulva and vagina, and restlessness. The same author states that the dioestrus cycle (rest period) is usually sixteen days in the ewe. The cycle is repeated one or more times until conception occurs and the breeding season is over.

With respect to the duration of oestrus, Marshall and Millin (1917) report that the period in which the ewes will breed lasts from one to three days, though Winters (1925) gives one to two days or the same length as the heat periods recorded by Miller (1930).

In regard to the recurrence of oestrus Harper (1914) gives two or three weeks; Marshall and Millin (1917), fourteen to nineteen days; Anderson

[1] Experiment Station contribution No. 1466. Prepared in the Department of Animal Husbandry under the direction of Professor Valente Villegas.

(1924), sixteen to twenty-one days; and Winters (1925), sixteen days. As to the age of the ewe when the first oestrus appears, Winters (1925) states that puberty is reached when the ewe is from five to seven months. The ram, however, reaches puberty at a later period. Rice (1934) reports that puberty in sheep takes place when they are from four to six months.

As soon as oestrus stops it is a sign that the ewe is pregnant. The signs of pregnancy, according to Craig (1918), are (1) cessation of oestrus and (2) tendency to fatten in the early months of pregnancy. Winters (1925) states that the indications of pregnancy are marked development of the mammary glands of ewes not nursing young, abdominal enlargement especially on the left side, and increase in weight.

In his description of the symptoms of approaching parturition, Harper (1914) states that the lips of the vulva become somewhat thickened and stand farther apart than ordinarily, the ewe lies down and then rises again and may moan, indicating that labor has begun. According to Craig (1918) the signs of approaching parturition are: (1) the vulva becomes tumefied, (2) the labia become soft and flabby, and (3) the lining membrane is reddened. At the commencement of parturition, the abdominal contractions are short and feeble. As it progresses, the contractions increase in intensity and duration. Winters (1925) gives as the most conspicuous signs of approaching parturition, distended mammary glands and swelling of the lips of the vulva.

Craig (1918) states that the duration of labor is from fifteen minutes to one hour, and the interval between each lamb born is fifteen minutes to two hours. Miller (1930) reports that normal parturition lasts from fifteen minutes to one hour and Rice (1934), from thirty minutes to one hour for each lamb born.

Regarding the gestation period in ewes, Winters (1925) reports that the normal gestation period is usually from 143 to 150 days, Miller (1930), 146 to 152 days, usually 147 days, or 21 weeks, and Harper (1934), 145 to 150 days. Guevarra (1932) reports that a 20-year period of observation in the University of Wisconsin showed that the fine-wool breeds have a longer period of gestation, and that among 1,200 ewes, the period was from 146 to 147 days. Merinos and Cheviots have a gestation period of from 146 to 154, and 146 to 151 days, respectively.

In his study of the reproductive seasons of sheep at the College of Agriculture at Los Baños, Villegas (1929) found that 39.3 per cent of the matings took place in May and June and 21.2 per cent in December. These two periods indicate that grade Indian sheep breed twice a year. The records also show that of 33 lambings, 21.2 per cent occurred in May, and the rest, in October and November.

MATERIALS AND PROCEDURE

Materials

Ewes. Grade Indian ewes of varying ages were used in this experiment.

Rams. Bongabong, a grade Shropshire ram owned by the College, was used to breed the ewes at the beginning of the study. The sexually immature rams at the beginning of the experiment were used when they were sexually mature.

Barn. The sheep barn was used for housing the flock at noon, during rainy days, and at night. The walls and the floor, which was about one meter from the ground, were of bamboo. It had tile roofing to keep the air inside cool during warm days. It was constructed in such a way that the animals were protected from draft. Racks for feeding and salting were installed in the barn. A watering tank was also available to the flock at all times.

Pens. Two pens, one for housing the rams and the other for the ewe that was about to give birth, were used in the goat barn.

Watch. A pocket watch was used to determine the duration of oestrus; the time when breeding activities occurred; and the time when activities before, during, and after parturition took place.

Cloth band. A specially designed cloth band lined with cellophane inside was wrapped around the abdomen of the ram when it was set loose among the ewes. The cellophane lining of the band prevented the semen of the ram from passing through the cloth. This band prevented fertilization even if the ram mounted the ewes when impregnation was not desired.

Feeding and management of the ewes

The ewes and their lambs were pastured from eight to eleven o'clock in the morning and from two to four o'clock in the afternoon. At noon, at night, and on rainy days they were kept in the barn for shelter. When the rain was continuous, they were kept in the barn the whole day and provided with soilage of napier grass or guinea grass. Concentrate consisting of five parts by weight of fine rice bran, three parts of copra meal, and two parts of corn was also provided in amounts they could consume in one feeding. On ordinary nights, the ewes were provided with liberal amounts of concentrate and soilage. Clean drinking water was available at all times when they were in the barn.

Every ewe that was about to lamb was separated from the flock and placed in a pen to prevent the other ewes from molesting her during lamb-

ing. The dam was provided with soilage and concentrate. Both dam and lamb were allowed to go out in the yard in the morning and in the afternoon to receive sunlight. One week after lambing, the dam was allowed to pasture with the flock, so that the lamb was with its mother only at noon and at night. Dam and lamb were allowed to join the flock as soon as the latter was strong enough to go to the pasture.

Management of the rams

In order to control breeding, the rams were kept and fed in a separate pen. To keep the rams in good condition, they were given morning and afternoon the grain mixture used for the ewes and a generous supply of guinea grass or napier grass. When the rams were in the pen clean water and salt were available at all times. They were given exercise and sunlight by tethering them morning and afternoon. On rainy days they were kept in the pen and given soilage and concentrate.

Method of breeding

Every afternoon from 4:30 to 6:00 P. M., the ram with a cloth band around his abdomen was turned loose among the ewes. In about thirty minutes, he could find the females in oestrus. If it was desired to place in gestation the ewe in oestrus, the cloth band was removed from the abdomen of the ram to allow him to mate with the ewe. One month after a ewe had been served, she was taken away from the ram. After this period, however, she was again allowed to be bred if she came in heat. This interval between matings was necessary to determine whether the previous serving was successful or not. In this manner the exact period of gestation could be determined.

In order to ascertain the signs of pregnancy and approaching parturition, a ewe that had been served was weighed on the first, second, and third months after mating and then weekly up to the time of lambing. Changes in the size, shape, color, feel, and secretions of the vulva were observed daily. When a ewe was found to be in the later stages of pregnancy as shown by the marked enlargement of the lips of the vulva and marked distention and hardness of the udder, she was placed in a pen and observed continually to determine the signs and the beginning of labor. The marked changes manifested a few days before parturition to the beginning of labor were taken as the signs of approaching parturition, and the period from the beginning of labor to the expulsion of the young was considered the duration of labor.

From lambing to the time the ewe was in heat again, she was placed in her pen to determine the interval between parturition and the next oestrual period.

At the beginning of the experiment, it took several mountings to make one successful copulation. This made the ram so tired that he had to rest for a while before copulation again took place. After one successful copulation, both animals rested for one to three hours and then the ram mounted again for another copulation. This activity continued until the ewe was no longer in oestrus. During the period when the ram had the cloth around his abdomen, he kept mounting and following the ewe at a few minutes' interval until he panted and saliva dripped from his mouth. To prevent this from recurring, the ram and the ewe were allowed to be together only until the first successful mating.

To determine the recurrence of heat, duration of oestrus, and signs of oestrus in the ewe, the cloth band was tied around the ram's abdomen. Changes in the ewe's behavior, size and shape of the vulva, and color of the mucous membrane lining the vagina were taken as the signs of oestrus. Changes in the vagina were compared by inserting the finger into it during and after oestrus.

The duration of the manifestation of the peculiar behavior of the ewe when she allowed the ram to mount her indicated the period of oestrus.

RESULTS

Age at first oestrus

In one of the ewes oestrus appeared 409 days after birth and in the other, 262 days; the average was 335.5 days.

Age of rams at first mounting

When the rams were about eight months old they began to mount the ewes in heat. One ram began mounting the ewes in heat when it was 239 days of age, the other at the age of 263 days. The average age was 251 days. Owing to the lack of materials, only one ram was observed to effect the first successful fertilization of a ewe in oestrus. The other ram was still unable to effect fertilization when the experiment terminated. Successful fertilization was accomplished when ram No. 149 was 336 days old.

Signs of oestrus

When the ram was turned loose among the ewes, he could readily locate those in heat as he smelled the vulva and licked the side of the ewes. In all cases, ewes in oestrus when licked on the side by the ram turned

their heads toward the ram's head. Ewes in their first oestrus manifested slight swelling of the lips of the vulva and their mammary glands became bigger and firmer. When the forefinger was inserted inside the vagina before the ram could mount the ewe the sphincter muscle was felt to be loose and slimy. Upon withdrawal of the forefinger, a whitish, slimy fluid oozed out of the vulva. Ewes in heat, would run away from the ram in the first or second approach, but later they became docile when they were caressed or licked on the side. The docility of the ewes enabled the ram to mount them. The appetite of the ewes in heat was not changed.

Duration of oestrus

The duration of oestrus among ten ewes varied from 14 to 71 hours with a mean of 28.85∓5.90 hours.

Interval between oestrual periods

Statistically treated the intervals between the first and second, second and third, and third and fourth oestrual periods did not differ markedly. They varied from 11 to 45 days with a mean of 17.1∓1.2 days. This finding agrees with the observations of Winters (1925).

Interval between parturition and the next oestrual period

In regard to the interval between parturition and the next oestrual period it was noted that in the ten ewes observed it varied from 26 to 38 days, with a mean of 32.4∓1.0 days.

Behavior of the ram and the ewe at breeding time

When a ewe was found by the ram to be in oestrus, both left the flock, and the ram began to mount her. Except for the lambs which interfered in the activities of the pair they were not molested. At this time the ram was so possessive of the ewe that he even drove away the lamb that she happened to be nursing. Depending upon the vigor of the ram and the temperament of the ewe, it took several mountings to make a successful copulation. Of the two rams used for breeding, the younger required an average of three mountings to make one copulation, and the older an average of five. Some of the ewes in oestrus were excited when the ram mounted them. They stepped forward or moved their hips sidewise thereby preventing successful copulation. Ewes at the height of their oestrus, however, were very docile and did not move when the ram mounted them. Whether copulation took place or not, the ram dismounted immediately after making three or four successive shoves of his hips. Then the ram went to the side of the ewe and excited her by licking her side before mounting again. In general, the ram smelled the vulva and then licked the side

of the ewe around the region of the shoulder before mounting. As the ram licked the side of the ewe, she turned her head towards that of the ram as if to acknowledge his desire, and then the ram stepped backwards and mounted her.

In copulation the ram mounted the ewe, placing the point of the penis at the vulval opening. A strong shove of the ram's hips so that he attained almost an upright position, pushed the ewe forward as the penis was inserted into the vagina. The ram made a peculiar groan. After copulation the ram dismounted slowly, went to the side of the ewe and drooped his head. Then both rested. If copulation was not accomplished, the ram continued to mount at intervals of five to twenty minutes. This interval was spent in resting and in exciting the ewe. If copulation was successful, both ewe and ram rested standing with their heads drooping. The ram was always at the side of the ewe and followed wherever she went. After a while they ate soilage or chewed their cud. This period of rest lasted from two to three hours before the ram began to mount again. This activity was repeated until the ewe was no longer in oestrus.

It took the ram an average of one to two minutes to excite the ewe, two to four seconds to copulate, or a total of one minute and two seconds to two minutes and four seconds from exciting to dismounting.

Signs of pregnancy and approaching parturition

The monthly weights of the ewes increased from the time of impregnation to the time of parturition. The ewes observed gave a mean weight of 25.73∓0.76 kgm. after the first month following copulation, 27.09∓0.62 kgm. after the second month, 28.04∓0.64 kgm. after the third, 29.71∓0.61 kgm. after the fourth, and 31.41∓0.59 kgm. after the fifth month, or before the time of parturition. It took 112.8∓3.2 days from impregnation before the enlargement of the abdomen became noticeable; swelling of the vulva, 127.8∓2.9 days; enlargement of the udder, 116.4∓5.4 days; prominence of the milk veins, 125.8∓3.7 days; further enlargement of the vulva, 144.1∓0.7 days; further distention of the udder, 145.6∓0.8 days; and presence of mucoid substance on the vulva, 145.8∓0.9 days.

Gestation period

The gestation period of the eight ewes varied from 144 to 150 days, with an average of 146.9∓2.3 days. This figure is in close agreement with that of Guevarra (1932), Harper (1914), and Winters (1925). Three of the eight fertile matings occurred in December and two in January, and most of the lambings took place in May and June. This observation

seems to agree with that reported by Villegas (1929) on the reproductive habits of the sheep at the College of Agriculture.

Duration of labor

The writer observed only two ewes giving birth. They bleated and were restless. They lay down and then rose. Vigorous contractions of the abdomen were noted at the beginning of labor. The expulsion of the fetus was taken as the end of labor. In one ewe the period of labor was 55 minutes, and in the other, 44 minutes. The results obtained by the writer agree with those of Rice (1934), Miller (1930), and Craig (1918).

Age of the ewes at first lambing

The age of six ewes at their first lambing varied from 379 to 838 days, with an average of 538 days, or 17 months and 23 days. Only ewe No. 146 had its first lambing in the course of the experiment. Data on the first lambing of the other ewes were obtained from the records of the Department of Animal Husbandry.

SUMMARY

1. Oestrus appeared in one ewe 409 days from birth, and in the other ewe, 262 days.

2. One ram began mounting the ewes in heat when it was 239 days old and the other ram at the age of 263 days.

3. The signs of oestrus observed were: (*a*) turning of the head of the ewe towards that of the ram when the latter licked the side of the former, (*b*) slight swelling of the vulva, (*c*) increase in size and firmness of the mammary glands of ewes in their first oestrus, (*d*) looseness of the sphincter muscle inside the vagina, (*e*) sliminess of the mucous membrane lining the vagina, (*f*) flowing out of a whitish, slimy fluid from the vulva upon withdrawal of the examining finger, (*g*) docility when licked by the ram, and (*h*) allowing the ram to mount.

4. The average duration of oestrus was 28.85 ∓ 5.90 hours.

5. The average interval between oestrual periods was 17.1 ∓ 1.2 days.

6. When a ewe was found in oestrus by the ram, both left the flock and began mating. The younger ram required less mountings than the older one in order to make one successful copulation. Ewes at the height of their oestrus were very docile and did not move when the ram mounted them. When copulation failed after the ram mounted the ewe, he always dismounted and excited the ewe before trying to copulate

again. Exciting the ewe took an average of one to two minutes and copulating, two to four seconds, making a total of one minute and two seconds to two minutes and four seconds.

7. The interval between parturition and the next oestrual period was 32.4∓1.0 days.

8. The weights of the ewes continued to increase from the time of impregnation to parturition.

9. After impregnation, marked enlargement of the abdomen in the ewes was observed in 112.8∓3.2 days; swelling of the vulva, in 127.8∓2.9 days; enlargement of the udder, in 116.4∓5.4 days; prominence of the milk veins, in 125.8∓3.7 days; further enlargement of the vulva, in 144.1∓0.7 days; further distention of the udder, in 145.6∓0.8 days; and presence of mucoid substance on the vulva, in 145.8∓0.9 days.

10. The average gestation period of the eight ewes under observation was 146.9∓2.3 days.

11. The average duration of labor was 49.5 minutes.

12. On the average, the age at first lambing of the six ewes was 538 days, or 17 months and 23 days.

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THE USE OF RICE SEEDLINGS IN THE DETERMINATION OF ROOT-SOLUBLE PHOSPHORIC ACID AND POTASH IN SOILS[1]

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Root-soluble phosphoric acid and potash play an important part in the metabolic processes of plants. In the literature on the biochemical method seedlings of temperate plants, such as rye, wheat, barley, oats, red clover, alfalfa, potatoes, turnip, sugar beets, and mangles, have been used. Inasmuch as it would be of interest to know the value of rice seedlings in this method, work was conducted in the Department of Soils from October, 1941, to September, 1942, to determine the amount of phosphoric acid (P_2O_5) and potash (K_2O) absorbed by seedlings of early- and late-maturing varieties of rice at different ages.

Review of literature

The seedling method of Neubauer is most extensively applied in European countries, especially in Germany. Wiessmann (1926) reported that Neubauer and Schneider noted that the foraging powers of seedlings of different temperate plants vary from 0 to 24 milligrams phosphoric acid, and from 5 to 100 milligrams potash per 100 grams of soil. These investigators established the minimum amounts of phosphoric acid and of potash which fertile soils should contain. They further suggested that 100 grams of fertile soil should have at least 5 milligrams of phosphoric acid and 15 milligrams of potash when rye seedlings are used in the experiment.

Roemer and Scheffer (1929) found that rice seedlings grown for 18 days absorbed an amount of potash which agreed fairly well with that utilized by the rye seedlings, particularly in acid soils. However, the amounts of phosphoric acid assimilated by rice seedlings were not concordant with each other.

Dietz (1931) reported that light did not have any significant influence on the ability of rye seedlings to absorb the root-soluble phosphoric acid and potash in soils.

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[1] Experiment Station contribution No. 1467. Based on the thesis presented by the senior author for graduation with the degree of Bachelor of Science in Agriculture.

As proof that the use of seedlings for extracting the soluble phosphoric acid and potash is more practical than either pure chemical, pot, or field methods, Thornton (1935) states that a large number of workers have used the seedling method in their studies of soils and fertilizers.

Ames and Gerdel (1927) state that early attempts to use the Neubauer method in the United States failed to give satisfactory results. Thornton (1931) attributed the failure to the fact that the seeds were not treated properly before planting.

Haley and Holben (1927), who modified the Neubauer method, found a close correlation between the quantities of potassium absorbed by the tops of buckwheat plants and those extracted by 0.2 N hydrochloric acid.

Wheeting (1930) found the Neubauer method with its modifications to be a good indicator of the potassium needs of soils.

Thornton (1931) and Lange (1925) stated that the Neubauer method gave results in concordance with the results of the pot and field tests.

Waksman and Starkey (1931) state that Dahlberg and Brown (1932) used the Neubauer method to standardize the Winogradsky method to determine phosphorus deficiency in soils.

Snider (1932) studied the amount of available phosphorus obtained by the Neubauer method, Truog chemical method (1930), and field method. He concluded that the yield of wheat obtained by the Neubauer and Truog methods compared favorably.

Galvez (1934) reported that the ability of rye seedlings to absorb phosphoric acid and potash in the soil increased as the texture of the soil became light. He also found that the seedlings had the tendency to absorb in 18 days as much as possible of the available nutrients from the soil.

Lea and Midgley (1934) found good agreement between the Neubauer and the chemical methods.

Pettinger and Thornton (1934) report close correlation among the Neubauer method, plant-sap analysis, and Hoffer stalk-test for determining the nutrient content of soils.

Thornton (1935) found that the Neubauer method is of value in testing mineral deficiencies in soils as well as in determining the amount of available plant foods in soils.

MATERIALS AND METHODS

Rice (*Oryza sativa* Linn.) Two rice varieties were used in this study, namely, Inintiw, an early-maturing variety, and Elon-elon, a late-maturing variety. The seeds harvested in January, 1942, were obtained from Bay, Laguna. According to the Department of Agronomy, Inintiw is a non-

bearded upland rice which matures in 125 days, whereas Elon-elon, although nonbearded, is a standard lowland rice which matures in 192 days. Inintiw is planted in upland fields in the later part of May or early part of June either by the ordinary broadcast method or with the use of an implement called *lithao*. It is a second-class rice that has an average yield of 34 cavans a hectare. Elon-elon is nonlodging and has good stooling quality. It is a superior-class rice, giving an average yield of 70 cavans a hectare.

The seeds were freed from unsound grains by placing them in rain water and discarding those that remained afloat. The apparently healthy grains were cauterized with 0.1 per cent solution of mercuric chloride ($HgCl_2$) by soaking the seeds in the disinfecting solution for at least half an hour. They were removed from the solution and then dried in the air. From these, 100 seeds of apparently similar color and size were selected by picking them up with a pair of forceps and placing them on a checker board. These 100 grains were weighed in an analytical balance. The average weight of 100 grains of the Inintiw variety was 2.3405 grams and that of Elon-elon, 2.3597 grams. The viability of the seeds was 95 per cent for Inintiw and 97 per cent for Elon-elon.

Soil. Lipa clay loam, shallow phase, collected from the hill behind the Department of Agricultural Botany, College of Agriculture, was dried in the air, pulverized, and passed through a 2-mm. sieve. The physical properties of the soil are as follows: moisture, 8.36 per cent; loss on ignition, 11.47 per cent; water-holding capacity, 61.72 per cent; colloid content, 55.45 per cent; and hygroscopicity, 14.98 per cent. The chemical properties of the soil are as follows: pH, 7.2; organic-matter content, 0.87 per cent; the available nutrients, P_2O_5, 0.01 per cent; K_2O, 0.02 per cent; plant foods held in reserve, SiO_2, 0.32 per cent; sesquioxide, 24.22 per cent; CaO, 0.60 per cent; P_2O_5, 0.16 per cent; K_2O, 0.12 per cent; MgO, 0.48 per cent; Na_2O, 0.19 per cent; SO_3, 0.15 per cent; and N, 0.14 per cent.

Dishes. Glass dishes with a diameter of 12.0 cm. and a height of 6.5 cm. were used. Each dish was numbered and provided with a glass tubing about six centimeters long for aëration.

Sand. The sand was collected from Mayondon, Los Baños, Laguna. It was passed through a 2-mm. and a 1-mm. sieve. Only the particles which passed through the 2-mm. sieve and remained in the 1-mm. sieve were taken. The sand was washed with tap water to remove the silt and clay particles which adhered to the sand grains and then soaked in a dilute solution (1: 3) of hydrochloric acid for about two days. It was washed with rain water until free from acid. The reaction of the sand medium was adjusted by the addition of dilute (1: 4) ammonium hydroxide solution

so that it had the same pH value as that of the soil having a pH of 7.2. Then the sand was dried in the air before it was used.

Procedure. Two plantings for each variety were carried out. For each planting, 88 glass dishes were divided into 11 lots of 8 dishes each. The first 4 dishes of lot I were used to hold the sand-soil mixture, and the other 4, sand alone. The remaining 10 lots (II to XI) were divided in a manner similar to that employed in lot I.

The treated lots consisted of a mixture of 100 grams of soil and 50 grams of sand spread evenly in the dish having in the center a short glass tube which served for aëration and watering. The surface was moistened as uniformly as possible with 20 milliliters of rain water and then covered with 180 grams of sand. It was moistened again as uniformly as possible with 40 milliliters of rain water. With a pair of forceps 100 rice grains were planted equidistant in the media, covered with 70 grams sand, moistened in the usual way with 20 milliliters of rain water, and then weighed. The control lots containing sand alone were prepared in a similar way. They were placed side by side with the treated lots. Both the control and treated lots were covered with cardboards until the seedlings were taller than the upper edge of the dish. By watering each culture daily its weight after planting was maintained constant until harvest.

Lot I was harvested eight days after planting, and each succeeding lot two days later than the preceding lot. The seedlings were removed from the dish as carefully as possible, washed with running water until free from soil and sand particles, and then analyzed chemically for the P_2O_5 according to the Dalberg and Brown (1932) method and the K_2O by the Bry (1932) process recommended by Merkle (1940).

RESULTS

A preliminary experiment was conducted to determine whether or not seashore sand which had been previously treated with hydrochloric acid could be used in the experiment in place of pure quartz sand. For the purpose, six dishes were used: three for the sand-soil mixture and three for the sand alone. The result of the trial showed that the difference between the amount of root-soluble phosphoric acid and potash absorbed by the seedlings grown in a mixture of soil and pure quartz sand and that of soil and acid-treated sand is insignificant. In other words, the acid-treated sand can be used in the experiment instead of pure quartz sand. On the other hand the difference between the amount of root-soluble phosphoric acid and potash removed by the seedlings grown in a mixture of soil and pure quartz and that of soil and untreated sand is significant in favor of the untreated sand.

It was observed that the seeds planted in sand alone germinated one and a half to two days earlier than those in the sand-soil mixture; consequently, the control seedlings were taller than those grown in the sand-soil mixture in the early stages of growth. After 10 to 12 days, however, the seedlings in the treated lots readily showed marked improvement and became even taller than those in the control, whose root systems were coarser and shorter than those in the sand-soil mixture. The roots of the latter were fine, long, and concentrated mostly at the bottom of the dish. They became distinct after 12 days of growth. The leaves soon became longer and wider than those of the control. On the fourteenth day, a bluish green to violet color was observed to form near the tips of the young leaves of the seedlings. The color spread first upward and then downward. The seedlings, however, remained normal and continued to grow. As the seedlings became older, the colored portion of the leaves assumed a yellowish to reddish brown coloration similar to the symptom of potash deficiency reported by Ekstein (1937). According to this author the deficiency is conducive to the formation of thin ears and poor grains. The writers observed that most of the seedlings that were harvested after 14 days had empty hulls. The grains which failed to germinate in the treated lots ranged from 4 to 6 per cent; in the control lots, 0 to 3 per cent. The writers also noted that the seedlings which were allowed to grow up to 24 days began to wilt and had stunted growth. This seemed to indicate that the removal of soil nutrients by the seedlings began to cease. At the age of 28 days, the majority of the seedlings wilted and some of the leaves severed from the stem, thus making harvesting difficult.

DISCUSSION

The writers found that during the first ten days of growth, the amounts of phosphoric acid removed from the soil in both plantings had negative values, indicating that these nutrients migrated from the cell sap to the soil. The amounts of potash absorbed showed parallel trend of results. These findings do not seem to be in accord with the established fact that soluble substances in the cell cannot pass into the soil. The peak of absorption was reached at 16, 18, and 20 days, after which the absorption began to fall and thus indicated that there was no more increase in absorption. Since at these ages the amounts of phosphoric acid and potash removed from the soil by the seedlings did not show distinct variation from each other, it would seem difficult to ascertain at what age or ages the seedlings attained their maximum absorption. The statistically treated (Love, 1938) data corresponding to these ages, 14 to 26 days, showed that the age of seedlings influenced the absorption of soil phosphoric acid, the

F-value being highly significant. Planting gave also a significant F-value in favor of the second planting. On the other hand, the other two sources, namely, variety and replication, were both insignificant. This indicated that the Elon-elon and Inintiw varieties of rice can be used interchangeably in the Neubauer method of determining soil fertility. With regard to replication, the results showed that the amounts of phosphoric acid removed from the individual pots were statistically uniform. When the mean evaluated values are assessed in accordance with the least mean difference for weights corresponding to ages, one might infer that the seedlings harvested at the ages of 18, 20, and 22 days absorbed a maximum amount of phosphoric acid. No statistically significant difference was found between the ages of maximum absorption.

The amounts of root-soluble potash in milligrams absorbed by rice seedlings at different ages showed that the only source of variation which showed significant influence on the absorption of soil potash by rice was age. When the least mean difference was used, it was apparent that the seedlings which were allowed to grow up to 16, 18, and 20 days absorbed the highest amount. Like phosphoric acid, no significant difference was found between the ages of maximum absorption of potash. The result showed further that Inintiw can be used in place of Elon-elon and that the four replications in a lot have uniform values. When the data were subjected to the analysis of covariance the writers found no correlation between the amounts of phosphoric acid and potash absorbed by the rice seedlings at the different ages.

SUMMARY

1. The study of the use of seedlings of Elon-elon and Inintiw in the determination of available phosphoric acid and potash in soils indicated that either Elon-elon or Inintiw may be used in the seedling method of determining soil fertility.

2. Seashore sand, when properly treated with hydrochloric acid and washed carefully with water, can be used in the Neubauer method in place of pure quartz sand.

3. The maximum absorption of the root-soluble phosphoric acid by rice seedlings was attained at the ages of 18, 20, and 22 days, and that of root-soluble potash at 16, 18, and 20 days. Since the root-soluble phosphoric acid and potash in the Neubauer method are always determined in the same harvest, it is recommended that rice seedlings be harvested at the ages of 18 to 20 days.

4. The date of planting appeared to have an influence in the absorption of root-soluble phosphoric acid but not in the absorption of root-soluble potash.

5. The individual culture in a lot gives uniform value of phosphoric acid and potash when compared with one another, indicating that four replications are sufficient.

Potash-deficiency symptoms in rice seedlings were shown by the appearance of a bluish-green to violet color near the tip of the young leaves and yellowish to reddish brown at the tip of the older foliage.

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PHYSIOLOGICAL STUDIES ON PHILIPPINE HORSES: I. NORMAL HEMOGLOBIN CONTENT, TEMPERATURE, RESPIRATION RATE, AND PULSE RATE IN THE MARE[1]

SIXTO E. DIAZ

Studies on the hematology of cattle in the College of Agriculture have shown that the body temperature rises with a rise in the temperature of the air, but the amount of hemoglobin decreases with a rise in body temperature. As no work has yet been done on the response of Philippine horses to their environment, this study was conducted from December, 1941, to November, 1942, to determine (*a*) the hemoglobin indices of adult Philippine mares; (*b*) if the fluctuation follows the normal curve in the different months of the year; (*c*) the fluctuation in pulse and respiration rates throughout the year; (*d*) whether or not correlation exists between physiological processes and external influences; and (*e*) the body temperature.

REVIEW OF LITERATURE

In regard to the influence of climatic conditions upon farm animals, Gonzalez (1926) stated that tropical climate has proved to be unsuitable to the health of farm animals imported from temperate countries.

Manresa and Reyes (1934) found that the hemoglobin content of Hereford and Holstein cattle reared in the Philippines is lower than that reported for these breeds of cattle in the United States.

Regan and Richardson (1938) stated that pulse rate in dairy cows is negatively correlated with hemoglobin indices.

Gonzaga (1930) found that pulse rate of native horses ranged from 38 to 50, respiration rate from 20 to 32, and body temperature from 37.4°C. to 38.4°C.

Dukes (1938) gives the normal respiration, pulse rate, and body temperature obtained from investigations on horses outside the Philippines as follows:

AUTHORS	PULSE	RESPIRATION	TEMPERATURE
Paton, Orr	36 — 40	—	—
Malkmus	28 — 40	8 — 16	37.5°C. — 38.5°C.
Smith	36 — 40	8 — 16	37.7°C. — 38.0°C.
Udall	38 — 50	8 — 16	37.5°C. — 38.5°C.

[1] Experiment Station contribution No. 1468. Prepared in the Department of Animal Husbandry under the direction of the late Associate Professor Miguel Manresa.

MATERIALS AND METHODS

Animals

The six adult Philippine mares used in this work are described below:

NAME OF MARE	AGE *years*	COLOR	WEIGHT *kgm.*	HEIGHT *cm.*	NUMBER OF RECENT FOALING
Parang	17	Buckskin	234.6	118.0	1
Bukid	9	Bay	235.4	113.3	1
Peralta	13	Gray	293.6	116.8	1
Tiosejo	8	Isabella	225.4	120.0	—
Villegas	6	Bay	264.7	127.4	—
Los Baños	5	Brown	227.2	124.0	1

Procedure

The determination of the items set forth in the objectives was done every Saturday afternoon at two o'clock and continued for one year, with an interruption of one week. The animals were maintained in as normal surroundings as possible.

Body temperature. The "S. L. Standard" thermometer which was graduated accurately to one-tenth degree was fully inserted into the rectum where it was held for not less than three minutes as suggested by Malkmus (1920).

Respiration rate. The rate of respiration was taken by placing the right hand with its back close to the nostrils of the horse so that the breathing, which was very distinct, was recorded in the hand tallymeter. The average of three determinations was taken as the respiration of the animal for the day.

Pulse rate. The pulse rate was taken by placing the index, middle, and third fingers over the submaxillary artery in the lower jaw. The number of expansions of the arterial wall beneath the fingers was counted for one minute, three times, and the average was taken as the pulse rate of the animal. The time was determined by means of the stop watch, and the pulse rate by the hand tallymeter.

Hemoglobin content. The blood sample was taken from the dorsal side of the pinna of the ear. The hair was cut short and the skin cleaned with alcohol. The largest vein was pricked with a needle, and 0.1 cc. of the blood was sucked into a 5 ml. pipette and diluted with 0.1 per cent alcohol to the 5 ml. mark. The hemoglobin indices were determined by means of the improved Newcomer Model 1919 hemoglobinometer. The average of three readings was recorded as the hemoglobin index for the day.

RESULTS

Body temperature. The average body temperature of six Philippine mares during the experiment for a period of one year was found to be 38.11°C.∓0.034°C. This average is slightly higher than the 37.9°C. reported by Gonzaga (1930), whose data, however, were for both males and females taken twice daily, at six o'clock in the morning and at four o'clock in the afternoon, and for a period of less than one year. His data presented for the females were higher than those for the males, and afternoon temperatures of both males and females were higher than their morning temperatures. The average body temperature of horses reported by Malkmus, Smith, and Udall is lower by 0.1°C. than that found in this study. This slight variation of 0.1°C. is not surprising in view of the fact that the present data are all from mares, whereas those of Malkmus, Smith, and Udall as well as those of Gonzaga, are from both males and females.

The analysis of variance reveals that body temperature varied very significantly in different individuals and in different months of the year. The high body temperatures occurred during the hot months and low body temperatures in the cooler months.

According to Gonzaga (1930), various factors cause variation in body temperature among animals of the same species and even in the same individual. Among these factors are age, sex, temperament, prehension of food, atmospheric temperature, restlessness, and muscular exertion. No evaluation, however, was made of the effect of each of those factors or any combination of them.

Respiration rate. The average rate of respiration is 27.42∓0.474. This average differs from that reported by Gonzaga (1930) by less than 1.5 per minute for both males and females, the average reported by him being 26. The figures reported by workers in the United States, which were 8 – 10 and 8 – 16 per minute (Dukes, 1938), however, are decidedly lower than those found here. The difference in the rate of respiration between Philippine horses and horses in the United States is so great that possible explanations other than difference in size and effect of tropical heat (Dill, 1938) should be studied.

The rate of respiration is high from February to July, which are considered hot months, and low from August to December, which are cooler months. The fluctuation is abrupt, showing that there is a sudden change in respiration among native mares. The rate of respiration varies significantly among different individuals and according to the seasons of the year. Two mares, Villegas and Bukid, breathed significantly faster during the hot months.

Pulse rate. The average pulse rate found in this study is 38.33∓0.507. The range of pulse rate of 35 to 45 per minute is very close to that reported by other investigators (Dukes, 1938). It is generally recognized that pulse rate is very sensitive to external influences. Smith (1921) stated that even harsh words tend to double the heart beats.

The variation of pulse rate in six native mares revealed that pulse rate is sensitive to stimuli of the nervous system. Any abrupt change in pulse rate does not mean that the animal is abnormal. Significant differences in the pulse rate exist between individuals and in different months.

Hemoglobin. The average hemoglobin determination was 11.72∓0.140 grams per 100 ml. of blood. Dukes (1938) reported that Kuhl found the average hemoglobin content of American horses (breed not mentioned) to be 12.4 grams per 100 ml. The analysis of variance shows that hemoglobin indices of Philippine mares vary significantly with the months and among different individuals. Manresa and his coauthors (1934, 1939) have shown the influence upon hemoglobin of a number of internal and external factors, such as breed, age, feed, condition of the animal, and time of sampling. Furthermore, it is likely that other factors not well understood are at work.

The interaction of factors

In evaluating the influence of internal factors, such as body temperature, rate of respiration, pulse rate, and hemoglobin content of the blood, correlations of these factors were made.

Simple correlation. The results of simple correlation of body temperature with respiration, pulse rate, and hemoglobin; of respiration with pulse rate and hemoglobin; and of pulse rate with hemoglobin are summarized below:

Body temperature	× respiration rate, 0.4121
	× pulse rate, 0.5889
	× hemoglobin count, 0.3027
Respiration	× pulse rate, 0.1744
	× hemoglobin count,-0.0120
Pulse rate	× hemoglobin count, 0.5658

The foregoing data show that change in body temperature is accompanied by positive changes in the rates of respiration and pulse rate and in the amount of hemoglobin in the blood, the correlation coefficients being 0.4121, 0.5889, and 0.3027, respectively. These correlation coefficients are significant at one per cent level for 70 degrees of freedom. Likewise, the pulse rate is positively correlated with

hemoglobin, the correlation coefficient being 0.5658, which is also significant at one per cent level for 70 degrees of freedom. On the other hand, respiration did not correlate with pulse rate and hemoglobin, the coefficients of correlation being 0.1744 and - 0.0120, respectively.

The absence of correlation between respiration and pulse rate is worth noting in view of the finding of Regan and Richardson (1938) that in dairy cows, as body temperature is increased above normal, there is a reciprocal lowering of pulse rate. It seems that in the case of the six mares, the same correlation does not hold true under normal conditions when animals are not under strain, or when they are free from disturbances.

Multiple correlation. To find the dependence of increase in hemoglobin indices on the increase of both body temperature and pulse rate, multiple correlations were made. The coefficient of correlation for respiration was excluded in view of the fact that the correlation between respiration and hemoglobin was negative, although not significant. By means of the regression equation, it was found that the multiple correlation coefficient being 0.5671, the degree of dependence amounted to 17.63 per cent, indicating that temperature and pulse rate contributed approximately 18 per cent to the increase of hemoglobin.

Reaction to external factors

Simple correlation. In evaluating the influence of the external factors, atmospheric temperature and relative humidity, on the internal factors, body temperature, respiration rate, pulse rate, and hemoglobin content, simple correlations of these factors were made. These correlations are summarized as follows:

Average atmospheric temperature	× average hemoglobin, 0.1365
	× average body temperature, 0.2618
	× average respiration rate, - 0.0961
	× average pulse rate, 0.1699
Average relative humidity	× average hemoglobin, - 0.0569
	× average body temperature, - 0.0927
	× average respiration rate, 0.2159
	× average pulse rate, - 0.2129

All these correlation coefficients are insignificant, indicating that the external factors studied did not exert direct influence upon any one, singly, of the four internal factors investigated.

Multiple correlation. To determine the degree of dependence of body temperature on the internal processes, such as respiration rate, pulse rate, and hemoglobin, multiple correlations were made.

Body temperature. The data show that the dependence of body temperature on the internal processes studied amounted to 25.54 per cent, indicating that these internal processes contributed about 26 per cent to the increase in body temperature. Other factors besides those studied must have been responsible for the remaining 74 per cent of the increase. To find out what fraction of the remainder was attributable to the external influences, temperature and relative humidity, correlations of internal factors with atmospheric temperature and relative humidity were made The data revealed that atmospheric temperature and relative humidity failed to show significant correlation even at 5 per cent level, indicating that those factors did not affect directly the body temperature of the animals.

Respiration rate. The degree of dependence of increase in the rate of respiration on the increase in both body temperature and pulse rate amounted to 9.31 per cent. Again, it was found that the atmospheric temperature and relative humidity did not affect directly the changes in the rate of respiration. The coefficients of correlation of the rate of respiration on these factors being $+0.2618$ and -0.0927, respectively, they are not significant even at 5 per cent level.

Pulse rate. Dependence of pulse rate on body temperature, respiration rate, and hemoglobin was 30.16 per cent. As in body temperature and respiration rate, atmospheric temperature and relative humidity did not affect directly the changes in pulse rate.

Hemoglobin. The degree of dependence of hemoglobin on body temperature and pulse rate was found to be 17.63 per cent. Atmospheric temperature and relative humidity did not have a direct effect on the changes of hemoglobin.

SUMMARY

1. Physiological studies were undertaken on six mature Philippine mares with an average body temperature of $38.11°C.\mp0.034°C.$; respiration rate, 27.42 ∓ 0.474; pulse rate, 38.33 ∓ 0.507; and hemoglobin indices, 11.72 ∓ 0.140.

2. The behavior of these internal factors, how they are affected by external factors, such as atmospheric temperature ($28.64°C.\mp0.363°C.$) and relative humidity (70.36 ∓ 1.422 per cent) were studied.

3. The body temperature varied significantly from month to month and was greatly affected by other internal factors but was not affected directly by external factors.

4. The respiration rate varied from month to month and was affected positively by both body temperature and pulse rate, but not by hemoglobin.

5. The pulse rate varied significantly from month to month and was affected positively by the combined action of respiration rate, body temperature, and hemoglobin indices, but not directly by external factors.

6. The hemoglobin indices varied very significantly with the months, increased by combined action of body and pulse rate, but they were not directly affected by respiration rate and by external factors.

7. The relationship between hemoglobin and respiration was negative. As the respiration rate decreased, there was a corresponding rise in the hemoglobin index, or vice versa.

8. The coefficient of correlation between hemoglobin and relative humidity was negative and insignificant.

9. The significant variation of body temperature was due to the combined action of the three internal factors, hemoglobin, respiration rate, and pulse rate, and not directly to external factors.

10. The present study points, therefore, to a successful local environmental adaption of the Philippine mare and to its ability to regulate internal processes under changing external factors.

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INTRODUCED RAMBUTAN TREES IN THE COLLEGE OF AGRICULTURE AND THEIR PROPAGATION BY INARCHING[1]

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WITH ONE TEXT FIGURE

In 1934 Gonzalez reported inarching kapulasan on bulala stock. The inarched tree is now growing much more vigorously than kapulasan inarched on kapulasan and has flowered regularly since 1942. Mendiola (1941) reported the fruiting of budded kapulasan at an altitude of 50 to 80 meters in the College of Agriculture at Los Baños, Laguna. Because of the close similarity among rambutan, kapulasan, and bulala not only in the character of the plants but of the fruits as well, it would be desirable to point out certain outstanding differences that would facilitate recognition of the plants, especially by the layman. The present study was made to compare the different varieties of rambutan and bulala as to superiority in eating and other qualities of the fruits, to employ a dependable and fairly rapid method of asexual method of propagation of the rambutan, and to study the suitability of the bulala seedling as stock for the rambutan.

MATERIALS AND METHODS

The following were used in the study: (*a*) eight budded rambutan, trees planted back of the nursery building; (*b*) six seedling rambutan trees in the College orchard; (*c*) eight bulala trees, one in the Faculty Hill and one in a yard adjoining the College campus; (*d*) nine budded kapulasan trees, two in the nursery, two in the Faculty Hill, and five in barrio Bancal, Los Baños; (*e*) various tools and materials for inarching; and (*f*) some laboratory facilities for pomological study. The points selected for study were (*a*) general appearance of the tree, (*b*) features of the leaf, (*c*) flowering and fruiting, and (*d*) characteristics of the fruit.

With regard to the general appearance of the tree, form and size, mode of branching, and color of the tree from a distance were studied.

From each of the three nepheliums 150 leaves were picked at random and examined for length and width of leaflet, number of leaflets in a rachis, venation of the leaves, color of both sides of the leaves, and other characteristics.

[1] Experiment Station contribution No. 1469. Based on the thesis presented by the junior author for graduation, April, 1947, with the degree of Bachelor of Science in Agriculture.

As soon as the flower buds began to form, they were visited daily to note the date and time of the opening of the flowers, the dehiscence of the pollen, the approximate time of the day when pollination took place, the changes in the flower indicating response to fertilization, the date when the fruit became noticeable, the first sign of maturity as indicated by changes in color, and the time of harvesting. The different types of flower were also studied with a view to ascertaining the sex of the tree. The dehiscence of the pollen grain necessitated hourly examination of the flower from dawn till dark on certain days, particularly on days of varying weather conditions.

The fruit, whether borne singly or in clusters, was studied as to shape, weight in grams, color of the rind and the spines based on Ridgway's color standards and color nomenclature (1912), and the nature and size of the spines.

The flesh was examined for color texture, ease of separation from the seed, quantity of edible portion, and taste. In every case, the entire fruit was weighed first and then again as each part (rind, flesh, and seed) was removed.

Propagation

By seed. All the seeds of the rambutan and the bulala that could be gathered were cleaned, planted in seed boxes, and placed in partial shade. When the seedlings were about eight centimeters high, they were potted and placed in partial shade until they were ready for inarching.

Asexual propagation. Inarching was preferred to other methods because it is more dependable and demands the least special requirements for the seedling, such as a more definite size of the stem, and condition of growth when the bark slips readily and cambial development is more rapid. Although the modified Forkert Method would be a faster way of asexual propagation, it is applicable only when the condition of the seedling is as described above and is better called for in a long range, more intensive project of nephelium multiplication than has been attempted in this study. Inasmuch as the writers' main consideration was to use every stock available in order to increase the number of asexually propagated plants from each of the single-tree varieties, inarching was used.

In potting, the seedlings were placed close to the side of the pot, and not in the center, to facilitate inarching. Platforms of bamboo were built around the tree to about the level of most of the branches, and the stock was placed close to the selected branch. Incisions on one side of the scion and of the stock were made, and about one half of the thickness of each stem from five to eight centimeters long was removed. The two incised

portions were brought together and made to coincide. They were carefully tied, at first with a piece of string, and later with abacá tuxy when the string caused girdling of the bark even before union was effected. Care was taken to place the pot so that the scion was least bent to minimize distortion of the resulting graft. The plants were watered from time to time and given the necessary care.

In the preliminary experiment, a few plants were cut after 30 days, when the scion and the stock appeared to have united. When some of the inarches died, severing was postponed to determine the optimum time for the purpose.

RESULTS

In many parts of the Philippines there are now a number of seedlings of introduced rambutan intermixed with bulala plants.

In asexually propagated material seven years and nine months old, used in the present work, there was not enough difference in the mean height of the varieties considered to make height a basis for distinguishing the three plant forms. The rambutan tree, however, appeared to be generally taller than either the bulala or the kapulasan, the mean measurement being 5.8 meters for rambutan, 3.5 meters for bulala, and 3.1 meters for kapulasan. Similar differences in the mean girths of the trees were found, as the following figures show: rambutan, 35 cm.; bulala, 28 cm.; and kapulasan, 22 cm. Rambutan also leads in mean spread with its 4.5 meters, compared with bulala's 3.2 and kapulasan's 3.2.

As the trees became older, however, in this case about 15 years old, the bulala attained a much greater height than either of the other two forms, its mean being 8.5 meters, that of the kapulasan 6.2, and of the rambutan 5.8. The smallest full-grown bulala tree is much taller than the tallest of either kapulasan or rambutan. Similar differences were obtained in mean girth: bulala 87 cm., rambutan 49 cm., kapulasan 37 cm.; and in mean spread: bulala 9.1 meters, rambutan 5.5 meters, kapulasan 4.6 meters.

There are no trees in the campus much older than the fifteen-year-olds studied except bulalas grown from seed. These trees are in the forest and are estimated by Professor Eugenio de la Cruz of the School of Forestry to be about 50 years old. They grow side by side with large forest trees and compare favorably with the latter. At their full height in Java and under most favorable conditions neither rambutan nor kapulasan exceed 13 meters (Popenoe, 1920; Ochse, 1927). Perhaps when full grown, or from fifteen years and older, the bulala may be a larger tree than either of the other two; rambutan comes next and kapulasan last.

It may be of interest to note that of the budded kapulasans introduced from Java in 1939, only seven succeeded in establishing themselves. Five of these trees were killed in 1944. All the time, these kapulasans were very much smaller than the rambutan; they did not even reach half its size. This apparent inequality in vigor may help in distinguishing kapulasan from rambutan when they are planted side by side at an elevation not above 50 meters.

The length of the rachis did not give consistent differences either. For seven-year-nine-month-old trees, the rachis were 13.9 cm. in kapulasan, 12.9 in rambutan, and 6.16 in bulala. For the fifteen-year-olds, rambutan led with 15.1 cm., followed by kapulasan with 14.0 cm., and bulala with 10.3 cm.

The number of leaflets in a rachis and the size of leaflets seem to give more consistent values. Kapulasan and rambutan have about the same number of leaflets in both the seven- and the fifteen-year-old trees; bulala has less. The predominating number remained the same in the tests, six for kapulasan, six for rambutan, and four for bulala.

The leaflets of the rambutan and the bulala resemble each other very closely in many respects, including shape, size, and color of the upper surface. The colors of their nether surfaces, however, differ very much; that of the bulala is glaucous, and that of the rambutan, pale green. Because of the narrower leaves of the kapulasan, however, it is much easier to differentiate it from either the rambutan or the bulala.

The season of flowering and fruiting may help in further differentiating the bulala and the rambutan. Both the kapulasan and the bulala flowered about the same time, from February to March, and their fruit ripened four months later, from May to June. The rambutan trees, however, seedling and budded, flowered from April to June, and ripened also after four months, from September to November.

Pomological differentiation would further aid in the identification of the bulala and the rambutan. The fruit of rambutan possesses spines much finer and softer than those of bulala, which are short and stubby. There is considerably more aril in the rambutan than in the bulala. Also, the rambutan has a rather velvety texture and is sweeter than the bulala, which has a thin, somewhat mucilaginous flesh that is almost acidic in taste. In size the two fruits are not significantly different, but in percentage of aril, the mean for rambutan is 32.93, whereas that for bulala is only 17.20.

None of the kapulasan trees under study had matured fruit during the period of observation.

In this study, in which the fruits of seedling and budded rambutan trees were compared as to flavor, amount of aril, texture, and ease of separating the aril from the seeds, tree No. 3 was selected as the best and tree No. 4, second. The tree selected as the best had slightly larger fruit (although not significantly bigger) than that selected second. The second choice had a higher percentage of edible portion of aril. The other three

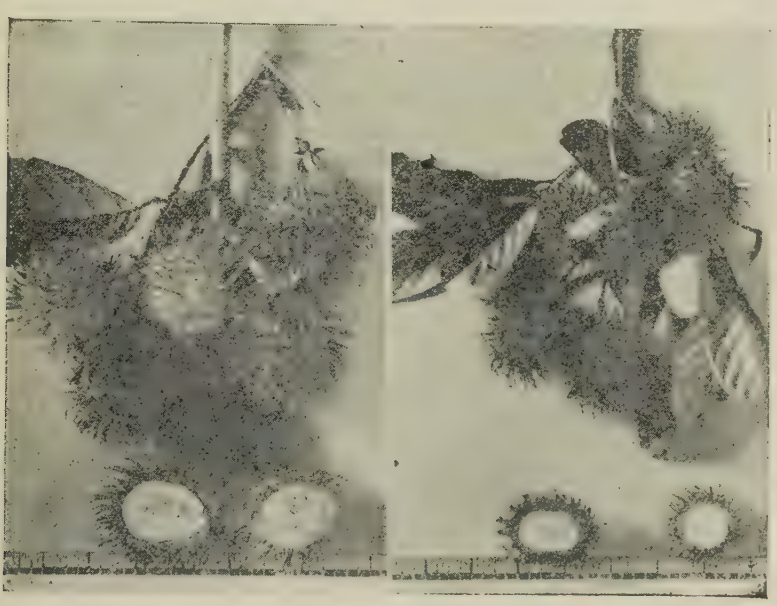

Fig. 1.—Left, a cluster of rambutan fruit of budded tree No. 3; right, a cluster of fruit from budded tree No. 4.

budded plants, numbers 5, 7, and 8, produced equally good-tasting fruit, although much smaller and with less percentage of aril than those of trees numbered 3 and 4. Besides the flesh could not be separated easily from the seed. The poorest specimen from the budded rambutan trees was far superior to the best of the seedlings.

The productivity of individual trees could not be utilized as basis for selecting the superior tree because the period of observation was limited to one crop; neither could resistance to infection by pests and diseases.

A study of the materials reported by Mendiola (1941) indicates that some confusion had crept in the distinction between the true Java rambutan and the native bulala. The writers noted that the bulala possesses sufficient distinctive characteristics to differentiate it from the kapulasan and the rambutan. It merits a name which will distinguish it from kapulasan and rambutan. To place it with kapulasan (Merrill, 1923; Brown,

1942) under the name *Nephelium mutabile* Blume will make the confusion more difficult to disentangle. A summary of characters prepared to facilitate the differentiation of the nepheliums follows:

a. Tree small, reaching about 6 meters in height, and 45 meters in spread; rachis 14 cm. long, often bearing 6 leaflets, which are the narrowest of the three nepheliums, 35 cm. wide and 12 cm. long, dark green on the upper surface and glaucous under. Flowers in January to March and ready to harvest between May and June. Spines on fruit short and stubby, flesh thick, of frosted pearl color, rather velvety texture, subacid to sweet ..... KAPULASAN

b. Tree large, 9 meters high, 9 meters spread; rachis 10 cm. long, with 4 leaflets, each measuring 13 cm. by 5 cm., dark green on the upper surface and glaucous on the nether surface. Flowers in January to March and ripens in May to June. Fruit bright red, with stubby, medium-sized spines, flesh thin and translucent, rather mucilaginous, sour to subacid in taste..... BULALA

c. Tree medium-sized, 6 meters high, spread, 6 meters; rachis 51 cm. long with 6 leaflets, each measuring 14 cm. by 6 cm., dark green on the upper side and light green on the nether surface. Flowers in April to June and matures in September to November. Fruit yellow or varying from light red to dark red, with slender, acute, and soft spines of the same or different color. Pulp thick, of frosted pearl color, velvety in texture, may or may not be separated easily from seed, subacid to sweet in taste..... RAMBUTAN

The record of planting and germination of rambutan and of bulala seeds shows that in three lots of bulala, it took the seeds nine days to germinate, with a percentage of germination ranging from 68.2 to 94.3. In the case of rambutan, the percentage of germination in six lots varied from 68.2 to 93.3 per cent, and it took the seeds nine to nineteen days to germinate.

The more vigorous seedlings of rambutan were ready for inarching in about 150 days, and of bulala in about 120 days. The less vigorous seedlings required a much longer time to reach the size suitable for inarching.

Because of scarcity of stock, the data were not sufficient for statistical analysis. The writers obtained consistently increasing percentages of success, from 45.8 per cent at the age of five months to 100 per cent at nine months. The result seemed to indicate the right age of seedling rambutan for inarching. At five months, the seedlings were about 25 cm. high and, except for the most vigorous seedlings, were a little difficult to inarch. Unless supported, the scion tended to pull the small-sized stock, resulting in distortion of the stock and of the resulting graft. When the seedlings were allowed to grow taller, there was a greater allowance for the incision and the seedling was large enough to withstand the pull of the scion.

The bulala seedlings gave similar results as the rambutan. The average percentage of success for the five lots of rambutan stock was 68.5, and for the four lots of bulala stock, 79.4.

Four rambutan seedlings about three years old and growing rather thriftily in kerosene cans, when inarched with branches of budded rambutan trees, were not ready for cutting until after six months. One plant which appeared to be already united to the stock was cut after four months, but it began to wilt soon after cutting and finally died. The death of the inarch suggested that there was incomplete union. With much younger stock, the inarches were ready for cutting in about forty days. The more rapid union achieved through use of younger seedlings as stock may be attributed to a more active cambial activity in the younger seedlings than in the older.

The result seems to indicate that the rambutan is a much better stock for rambutan than bulala from the standpoint of increment in height, although on the basis of growth in girth the reverse seems to be true. The result is of importance because hitherto bulala had not been used as stock for rambutan, although in 1934, the senior author reported successful use of bulala as stock for kapulasán.

SUMMARY

1. The budded rambutans from Java have proved well adapted to Philippine conditions. In quality, the better varieties compare well with litchi and possess many characteristics in common with it, including nature of flesh or aril and taste.

2. The rambutan can easily be inarched with either rambutan or bulala seedlings, the percentage of inarches being 68.5 and 79.4 per cent, respectively. The seed germinates in about nine to nineteen days, resulting in about 75 per cent germination. In about five months, rambutan is ready for inarching. The inarched plants are ready for cutting in 40 to 68 days. The percentage of success in inarching increases considerably from the fifth to the ninth month. Three-year-old seedlings are difficult to inarch perhaps because of less active cambial growth.

3. Reasonably consistent differences were found among the rambutan, the bulala, and the kapulasan which would facilitate their distinction.

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STRUCTURE OF CERTAIN SOIL TYPES IN THE COLLEGE OF AGRICULTURE[1]

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Bouyoucos (1929) found that dry soils, when placed in an excess of water, slaked at once into their natural structure. Only an application of a large amount of external energy, such as vigorous stirring, could break this structure into granules.

Aquino and Mamisao (1939) noted that the colloid content of the various soil types in a series varied with the texture of the soil. As the texture became heavier, the percentage of colloids increased.

Cox and Argüelles (1914) stated that the different sizes of sand and silt particles generally constituted the bulk of a given soil mass, and that their relative proportions determine largely the cultural qualities of the soil. They further said that a productive soil must have sand, silt, clay, and humus in proper relations and conditions in both the surface and substratum. Such conditions and relation tend to provide good drainage, aeration, movement and distribution of moisture, soluble constituents, and available water for crops. These factors are incapable of alteration as a whole, but it has been found practicable to modify and adapt some of them to local conditions.

Russell (1932) showed that cultivation does not itself form crumbs; it simply leaves the soil in the optimum condition for the weather to bring about the crumb formation. He said that crumb structures in soils can be altered not only by cultivation but also by addition of organic matter.

King (1919) pointed out that puddling or frequent stirring of heavy soils is detrimental to the growth of plants. The compound-grain structures are broken down. Through the action of rains, the soil grains run together into masses of a very close texture that young roots can hardly penetrate or if they can, will not allow them air. He advised that such soil should be allowed to fallow and given sufficient time to bring the soil particles together again into compound grains.

Robinson (1936) found that clay soil is very difficult to cultivate because when allowed to dry, it forms clods which make ordinary tillage operation very hard. Colloidal organic matter, as coatings of noncolloidal

[1] Experiment Station contribution No. 1470. Based on a thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture.

particles, proved beneficial in the formation of compound-particle structures or granules in the soil. He further stated that a considerable amount of clay increases the moisture-holding capacity of soils.

Since soil structure is an important basis for the study of many physical properties, such as percolation, drainage, aeration, penetration, and flocculation, and since it has some practical bearing on tillage, addition of organic matter, lime, and fertilizer to soil, the natural structure of certain soil types in the College of Agriculture was studied and the structures of cultivated soils were compared.

MATERIALS AND METHODS

Materials

The soils used in the study were medium phase Lipa clay loam from the sugar-cane breeding plots of the Department of Agronomy, College of Agriculture; deep phase Lipa clay loam from the Animal Husbandry pastures; shallow phase Ibaan clay loam from the old Rural High School garden plots near the Department of Agricultural Education building, and deep phase Los Baños clay loam from the coffee plantation of the College.

Medium phase Lipa clay loam has a dark brown to light brown surface soil. Its depth ranges from 25 to 45 cm. The texture is loose and friable. The subsoil, which is a brown clay loam, has a depth ranging from 25 to 90 cm. and is heavier in texture than its surface soil. Below the subsoil is the tuff, a yellowish brown to yellowish gray and moderately compact material which pulverizes easily when dry.

Deep phase Lipa clay loam is almost the same as medium phase Lipa clay loam except that the former has deeper horizons which are from 30 to 80 cm. in subsoil.

The depth of the surface soil of Ibaan clay loam, shallow phase, is from 0 to 15 cm. Its color is medium brown to dark brown. It is sometimes associated with gravel and fine granules of sand. The subsoil is not very well defined, but when it is examined it is generally light yellowish brown to mottled dark brown heavy clay loam. The depth ranges from 10 to 20 cm.

Los Baños clay loam, deep phase, has a dark grayish brown to brown clay loam surface soil. It has a loose and friable texture. The depth ranges from 30 to 40 cm. The subsoil is brown to mottled light brown, heavy clay loam, slightly compact, sticky and plastic when wet, and forms clods when dry. It is from 90 to 100 cm. deep.

Ten samples of each soil type were collected by digging a hole 30 cm. square to a depth which included the subsoil.

Wire bag. This was locally made out of 2-millimeter window screen as specified by Bouyoucos (1929). It was cylindrical in form, of about 5 cm. in diameter and 10 cm. in height.

Methods

The method of determining soil structure worked out by Bouyoucos (1927) was followed in this study. The moisture content of the samples was determined in accordance with the accepted method used by the Department of Soils, and the water-holding capacity of the samples was determined by the use of the Keen-Raczkowski brass box (Keen and Raczkowski, 1921) with a slight modification.

DISCUSSION OF RESULTS

The different types of naturally slaked soil showed different amounts of soil suspension at the end of 15 minutes. Deep phase Los Baños clay loam had comparatively greater slaking power than deep phase Lipa clay loam, medium phase Lipa clay loam, or shallow phase Ibaan clay loam. Lipa clay loam, both deep and medium phase, had more slaking power than the shallow phase Ibaan clay loam. The difference in slaking power between the deep and the medium phase Lipa clay loam was, however, not significant. These results seem to confirm the finding of Bouyoucos (1929) that soils possess a natural ultimate structure which is stable and definite for any one soil type.

The cultivated soil was found to have higher slaking power than the uncultivated soils. These results show that cultivation, such as plowing and harrowing, alters the natural arrangement of the structure of soils.

The surface soils possessed greater slaking power than the subsoils, with the exception of the surface of cultivated Los Baños clay loam, deep phase, and uncultivated Lipa clay loam, deep phase. It was also observed that surface soil slaked more easily and rapidly than the subsoil. This variation may be due to tillage operations, action of plant roots, addition of organic matter and fertilizers to soils, and exposure to changes in weather conditions.

Mechanical dispersion of the different soil types

The amount of materials that remained in suspension was greatly increased when the samples were mechanically dispersed for 10, 30, 60, and 900 seconds (15 minutes). This increase in suspension was so high in all soil types that the use of statistical treatment to differentiate mechanically dispersed from naturally slaked soils seemed unnecessary. To de-

termine whether soil types vary from one another in their colloid contents when mechanically dispersed for 15 minutes, the data were subjected to the analysis of variance. The different soil types showed significant differences in their colloid contents. Deep phase Los Baños clay loam has a much higher colloid content than deep phase Lipa clay loam. Lipa clay loam medium phase, and shallow phase Ibaan clay loam. Between the Lipa series and Ibaan clay loam, the difference in colloid content was also marked, in favor of Lipa soils. It seems evident that the differences were probably not only due to the types but also to the phases.

Cultivated soils showed a higher colloid content than uncultivated ones. This tends to show that cultivation increases the colloid content, resulting in the modification of the arrangement of structure and texture of the soil.

The results of the statistical treatment for horizons, and surface and subsoils when mechanically dispersed showed that unlike the naturally slaked soil, the subsoil contained in all cases comparatively larger amounts of colloids than the surface soil.

With the exception of deep phase Lipa clay loam the results showed that the cultivated subsoil had a greater colloid content than the uncultivated subsoil; the uncultivated surface soil contained more colloid than the cultivated surface soil. However, the cultivated surface soil of Lipa clay loam, medium phase, contained more colloid than the uncultivated surface soil.

Unslaked materials, moisture content, and water-holding capacity

The different soil types varied considerably in their content of slaked materials. Los Baños clay loam, deep phase, had the highest amount of slaked materials and Ibaan clay loam, the lowest.

The granules of the slaked uncultivated soils were coarser than those of the cultivated soils; the former had comparatively more unslaked materials than the latter. Subsoils contained higher amounts of unslaked granules which could not pass through a 2-mm. wire screen bag than the surface soils.

The moisture content varied with the types of soil. The uncultivated Lipa clay loam, medium phase, contained more moisture than the cultivated. All other soil types considered, it was noted that the cultivated soil held more moisture than the uncultivated soil.

Among the four soil types studied, only the surface of Ibaan clay loam, shallow phase, contained more moisture than its subsoil. In all other cases, however, the subsoil contained more moisture than the surface soil.

The four types of soil studied appeared to vary in their capacity to hold water. The agricultural conditions of the soils had a decided influence upon the moisture-holding capacity. Cultivation and high colloid content increased the water-holding capacity of the soil. The subsoils have a greater moisture-holding capacity than the surface soils.

SUMMARY

1. The four soil types collected from the College of Agriculture farms showed significant differences in their slaking power, colloid content, unslaked materials, moisture content, and water-holding capacity.

2. Deep phase Los Baños clay loam had the greatest slaking power, colloid content, unslaked materials, moisture content, and water-holding capacity, and shallow phase Ibaan clay loam had the lowest. It appears that the differences were probably not only due to the types but also to the phases.

3. The cultivated soils showed a greater slaking power and a higher colloid content, moisture content, and water-holding capacity than the uncultivated soils.

4. Cultivation seems to alter, at least to a certain degree, the natural ultimate structure of the soil; however, if fallowed for a sufficient length of time after cultivation, the soil may gradually restore its natural ultimate structure.

5. In general, the surface soils contained a greater amount of naturally slaked materials than the subsoils. The former slaked faster and contained lower amounts of colloids and unslaked materials than the latter. Their moisture content and water-holding capacity were also lower than those of the latter. The subsoils showed a greater tendency to slake into coarser granules or compound particles than the surface soils.

6. The structural difference between surface soils and subsoils may be due to tillage, action of plant roots, addition of organic matter and fertilizers, and exposure to weather.

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TAPILAN HAY MAKING[1]

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WITH ONE TEXT FIGURE

Tapilan, *Phaseolus calcaratus* Roxb., is widely grown in the province of Batangas, where the pods are harvested either green or dry for human consumption and the vines fed to work cattle. In 1934, efforts to produce field-cured tapilan hay were made at the Los Baños Economic Garden. Curing was successful, and the hay produced was satisfactory in palatability and storage quality. With the method employed, however, many of the leaves were lost through shattering.

The plant was first introduced for hay making in the College of Agriculture in February, 1931, by Assistant Professor F. B. Sarao of the Department of Animal Husbandry. From a handful of tapilan seeds planted on May 22, 1931, and yearly for three years, a sufficient quantity of seed was produced for studies in ensiling and hay making.

PRELIMINARY STUDIES

The first trial in tapilan hay making in the College was done in 1935. The seeds were planted in May and the vines were cut in August. Owing to rain, the vines could not be dried; hence no hay was made from the first harvest. In November, 1935, the second planting was made, and the vines were cut in February, 1936. The harvest was left in the swath to dry. The following day, the vines were turned over twice, late in the morning and in the afternoon. As the leaves shattered on the third day, the material was carted to the concrete drying floor of the Department of Animal Husbandry for further drying The third planting was made in November, 1936, and the vines were cut in February, 1937. The vines from the harvest were chopped with an ensilage cutter and dried on the concrete floor. The hay was baled and exhibited in the 1937 Philippine Exposition where it received the first prize. This recognition of tapilan hay as a promising stock feed in the Philippines has encouraged further studies. In November, 1937, the fourth planting was made, and in February, 1938, the plants were cut. The hay produced retained the green color, had a good aroma, and was highly palatable to cattle.

[1] Experiment Station contribution No. 1471.

PREPARATION OF TAPILAN HAY

Two cultures of tapilan in 1938-1939 and two in 1940-1941 were used in haymaking. Each culture was grown on 5,000 square meters of land. The tapilan hay produced from these cultures had the following proximate composition:

Moisture	15.50 per cent
Ether extract	3.29 " "
Ash	9.78 " "
Protein (N×6.25)	13.35 " "
Crude fiber	31.09 " "
Nitrogen-free extract	26.99 " "

There are three methods of making hay, namely, the swath, windrow, and cock methods. Each method has its own application, depending on weather conditions. According to McClure,[2] the swath method consists in leaving the material in the field when the day is cloudy and there is a good breeze. The material is tedded several times until well dried. The windrow method is practised during hot, dry, and sunny weather. The material is ready for hauling to the shed when the stem can be easily broken with two or three twists of the hand. The cock method is a continuation of the windrow method; the material is put into cocks for final curing after it has been in the windrow for some time.

The method described below differs from any of those already mentioned in that practically all the leaves are saved by drying the cut material on a concrete floor.

Harvesting

The tapilan vines were harvested when they were in full bloom, with only a few pods formed, and before any of the leaves showed signs of drying. This stage was regarded as the best for maximum production both in quantity and nutritive value of the hay. The vines were cut with bolos, either late in the morning or in the afternoon. They were put in small piles convenient for one man to fork into a bull cart (fig. 1, upper right). The harvest was then fed to an ensilage cutter that was operated by a 10 h. p. Deutz Diesel engine (fig. 1, upper left). In this way all leaves were saved.

Drying

The chopped material was spread in narrow strips on the concrete drying floor in order to expose it to direct sunlight and at the same time to hasten evaporation (fig. 1, lower panel). To ensure fast and even drying of the chopped tapilan, the strips were shifted to dry portions of the concrete

[2] McClure, H. B. 1918. Haymaking. U. S. Dept. Agric. Farmers' Bull. 943: 9–10.

floor at certain intervals. The drying process lasted from about 22 to 26 hours. Care was taken to rake the material into a shed at night to protect it from rain and dew.

FIG. 1.—Upper panel, tapilan being chopped with an ensilage cutter preparatory to drying. Lower panel, chopped tapilan vines spread on a concrete floor to dry.

Baling

In baling tapilan hay six men and two work carabaos were used. One man drove the team, another weighed the hay, two tended the feeder and

the press, and two others tied the pressed hay into bales with G.I. wire No. 16. The bales, consisting of six equal sections, weighed 30 kilograms.

Cost of production

The 1940-1941 tapilan harvest amounted to 2,788 kilograms of green vines, which when cured produced 877 kilograms of hay (31.49 per cent of the harvest).

The quantity of hay produced from the 1938-1939 and 1940-1941 cultures averaged 813 kilograms (1,626 kgm. a hectare). The total cost of production averaged ₱36.40. Of this sum, ₱3.00 went to the cost of the seed used; ₱17.51, to the cost of producing the vines; ₱15.16, to the cost of harvesting, hauling and chopping, drying, and baling; and 73 centavos, to the cost of the fuel, together with other miscellaneous expenses including interest and depreciation charges for the use of the equipment. Therefore, the calculated total charges for producing 1,000 kilograms of hay amounted to ₱44.65.

ELEVEN YEARS' STUDY ON "BUÑGA ÑG TUBO": A RÉSUMÉ[1]

RAFAEL B. ESPINO
Of the Department of Agricultural Botany

Extensive research data bearing on "buñga ñg tubo," *Aeginetia indica* L., a phanerogamic root parasite of the sugar cane plant which had been collected during eleven years prior to 1942, were totally destroyed through Japanese incendiary activity on or about February 27 or 28, 1945. Experimental and observational results on "buñga ñg tubo" that had been gathered by the writer, however, may still be recalled. The research project was started in 1930 mainly for, and with the full cooperation of, the Calamba Sugar Estate at Canlubang, Laguna. Mr. L. Weinsheimer, vice-president of that estate, considered this disease of the sugar cane quite serious in his plantations because the extent of damage was in some cases as much as 60 per cent loss of sucrose. Efforts were made, therefore, to study the parasite to find means of controlling its spread or of eradicating it altogether from the plantation. A series of experiments and observations were made in the experimental yard of the Department of Agricultural Botany and in sugar cane fields in Canlubang. The important findings so far made that can now be called back to mind are the following:

(1) Seen with a hand lens were seeds of the parasite clinging to cane points that were being soaked in water in a canal preparatory to planting. Likewise, seeds of the parasite were seen floating on and being carried by the water in irrigation canals. The parasite may, therefore, be introduced in the plantation during the planting of cane points and when the field is being irrigated with the water from the canal.

(2) A species of cogon, *Imperata exaltata*, growing abundantly along or near the Tagaytay ridge in Cavite was collected and shown to the writer by Mr. Rothkirch, field manager at the Calamba Sugar Estate. It was severely attacked as shown by the profuse growth of flowers of the parasite. This species of cogon, therefore, serves as a secondary host.

In pot cultures conducted in this department, *Aeginetia* plants attached to some roots of rice were also able to produce rather scanty and poorly developed flowers. Fortunately, the parasite failed to produce seeds, as the rice matured earlier and became dry long before mature seeds

[1] Experiment Station contribution No. 1472.

of the parasite could be formed. Upland rice plants, therefore, are rather unsatisfactory secondary hosts.

(3) Observations made in Canlubang and at the College showed that burning sugar cane trash and sprinkling boiling water (or steam) on the soil merely stimulated germination rather than killed the seeds of the parasite. No doubt some of the "buñga" seeds might have been destroyed by fire, but the growth of the parasite, apparently as a consequence of either of these treatments, was conspicuously heavier than that of the control, which received no treatment at all. This finding is important in connection with the work on eradication of the parasite from the soil.

(4) In tests made in pot cultures in Los Baños, destruction of the parasite or of its seeds by electrocution, by application of unslaked lime, or with the use of any of the commercial fertilizers, including calcium cyanamid, which yields caustic lime and free cyanamide to the soil, was found impossible.

(5) In the absence of a living host, seeds of *Aeginetia indica* failed to germinate under any of the conditions tried. Even the juice that had been extracted from the roots of the sugar cane failed to induce the germination of the seeds of the parasite. It appears, therefore, that there is something in the root of the living host that stimulates germination of the seed.

(6) Clay loam soil inoculated with the seeds of *Aeginetia*, one set kept moist in pots and another set dry, and planted monthly with sugar cane cuttings, produced results showing that the seeds of this parasite may remain viable 18 months in either moist or dry soil. It is quite probable that a longer period of hibernation or dormancy might have been obtained if more monthly plantings had been made, for previous studies reveal that the seed can remain dormant in the soil for about two years.

(7) The length of time necessary to start germination of the seeds of this parasite can not now be recalled, but from the time of planting sugar cane points in a soil previously inoculated with seeds of the parasite to the flowering stage of the latter was about five months. In cane plantings in February or March, beautiful clusters of flowers of *Aeginetia* could already be seen beginning to come out in August.

(8) Clusters of flowers of *Aeginetia* appeared in two places, near the base of the sugar cane stalks and far from it. The heavier growth of flowers and therefore of the parasite was invariably produced near the base.

(9) If infection occurred early, the cane plant became stunted in growth, usually ultimately dying. In many instances, however, the sugar cane

plants appeared normal in size and height and appeared healthy, but the juice in the stalks had low purity ratio, as revealed by analysis made in Canlubang.

(10) From the foregoing results of the experiments and observations, it becomes apparent that the most effective way of eradicating "buñga ñg tubo" from a plantation is by burning the trash, removing the stubbles, and planting the land to other crops. Efforts at other methods of control or eradication of the parasite were made. Pots of suitable size were inoculated with the seeds of "buñga" and planted to sugar cane cuttings. As was expected, the sugar cane plants grew, infection took place, and in due course flowers of the parasite began to appear. Then with a tool similar to a garden trowel but with a narrower blade and a longer handle (so that the worker does not have to stoop low), flowers or flower buds were destroyed as fast as they appeared by running the narrow blade into the ground to detach the roots of the sugar cane that had the parasite. Some of the sugar cane plants served as control. On reaching maturity, both the test and control canes were harvested, and with the cooperation of Mr. José K. Demeterio, formerly of the Department of Agricultural Chemistry, the sucrose contents of the stalks were determined. The data obtained showed that as the result of the "detaching" treatment, as much as 15 to 30 per cent of the sucrose that would have been lost if not treated was saved. Thus, on the basis of the results of this experiment as well as of those of previous ones, the following may be tried to eradicate *Aeginetia* from a sugar cane plantation:

(a) Burn the trash to destroy the seeds on or near the surface of the soil and generate heat to stimulate the germination of the remaining seeds and thereby effect their elimination from the soil.

(b) Remove the stubbles or root clusters of sugar cane when the field is not to be ratooned. When the infection is severe, ratooning should be avoided.

(c) With the use of a special narrow-bladed trowel, detach the infected roots of the sugar cane soon after the appearance of "buñga" flowers or flower buds. Repetition of this operation for a number of years or for as long as there is infection may ultimately eradicate the parasitic *Aeginetia indica* from the plantation.

(d) Prevent introduction of *Aeginetia* seeds into the plantation. Infected secondary hosts, such as *Imperata exaltata* growing near rivers or streams used for irrigating sugar cane fields should be eradicated.

COLLEGE AND ALUMNI NOTES

Rehabilitation of departments

Books have been donated for rebuilding the library by the following publishers:

1. Collegiate Press, Inc.
2. F. E. Compton and Co.
3. Rand McNally & Co.
4. Ginn and Company
5. Harcourt, Brace & Co.
6. McGraw-Hill Book Co., Inc.
7. Macmillan Company
8. Lea and Febiger
9. Morrison Publishing Co.

Publications and other papers have been received from the following institutions in the United States:

1. American Academy of Political and Social Science
2. American Book Center for War Devastated Libraries, Inc.
3. Boyce Thompson Institute for Plant Research, Inc.
4. Carnegie Endowment for International Peace
5. Cinchona Products Institute
6. Dennison University
7. Duke University
8. E. I. Du Pont de Nemours & Co.
9. Food Research Institute
10. Institutum Divi Thomae
11. Smithsonian Institution
12. Social Science Research Council
13. American Library Association
14. U. S. Department of Agriculture (shipment in 1945 lost in transit)
15. U. S. Public Health Service
16. Westinghouse Electric and Manufacturing Co.
17. Quartermaster Food and Container Institute (Annotated bibliography on cards)
18. Mellon Institute for Industrial Research
19. Hawaiian Sugar Planters' Association
20. United States Army

21. Philippine Detention and Rehabilitation Center
22. U. S. Government Printing Office

Other foreign institutions which have sent gifts:

1. Department of Agriculture, Sydney, Australia
2. Imperial Mycological Institute, Kew, Surrey, England
3. Board of Netherlands East Indies, Surinam and Curacao
4. Sociedade Broteriana Institute de Botanique, Coimbra, Portuga[
5. State Agricultural Library, Wageningen, Holland

Private donors:

1. Dr. M. A. McCall, Assistant Chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Dr. McCall will continue sending to the library current numbers of certain of the various journals. He contributed his complete set of the *Journal of the American Society of Agronomy.*
2. Dr. Francis O. Holmes, Department of Animal and Plant Pathology, Rockefeller Institute for Medical Research, Princeton, New Jersey. Dr. Holmes sent his own set of *Phytopathology.*
3. Dr. A. R. Moore, University of Oregon
4. Dr. E. B. Copeland, University of California
5. Dr. Edward A. Ackerman, Cambridge, Massachusetts
6. Mr. Edgar V. Seeler, Jr., Cambridge, Massachusetts (shipment of *Phytopathology* lost in transit)
7. Dr. Frank C. Gates, Kansas State University
8. Mr. J. Ross, Trenton 8, New York

Donors of mycological specimens, literature, etc., to the Department of Plant Pathology:

1. Dr. John A. Stevenson, Principal Mycologist in Charge, Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Maryland
2. Dr. A. G. Johnson, Principal Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Maryland
3. Drs. L. O. Kunkel, Francis O. Holmes, W. M. Stanley, and L. M. Black, Department of Animal and Plant Pathology, Rockefeller Institute for Medical Research, Princeton, New Jersey.
4. Mr. F. C. Bawden, Head, Department of Plant Pathology, Rothamsted Experimental Station, Harpenden, Herts, England

5. Dr. Helen Purdy-Beale, Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.
6. Dr. J. G. Leach, Head, Department of Plant Pathology and Bacteriology, University of West Virginia
7. Drs. Max W. Gardner, H. S. Fawcett, and C. M. Tompkins, University of California
8. Drs. G. W. Keitt, J. C. Walker, A. J. Riker, and James Johnson, University of Wisconsin
9. Drs. Eubanks Carsner, C. W. Bennett, N. J. Giddings, E. W. Brandes, R. D. Rands, and H. A. Allard, U. S. Department of Agriculture
10. Dr. C. J. Magee, Chief Biologist, Department of Agriculture, Sydney, New South Wales, Australia
11. Dr. Arthur F. Bell, Director, Bureau of Sugar Experiment Stations, Brisbane, Queensland, Australia
12. Mr. D. S. North, Pathologist, retired, Colonial Sugar Refining Company, Ltd., Sydney, Australia
13. Mr. J. P. Martin, Pathologist, Hawaiian Sugar Planters' Association, Honolulu, Hawaii
14. Dr. H. H. Storey, East African Industrial Research Board, Whitehouse Road, Nairobi, East Africa
15. Professor S. F. Ashby, Director, retired, Imperial Mycological Institute, Kew, Surrey, England.

The program for the major repair and reconstruction of buildings on the campus was started in December, 1946, with the west wing of the Agricultural Education building as number one on the list. The work was under the supervision of Professor Andres P. Aglibut, superintendent of construction.

The reconstruction of the Rural High School building, began in May, 1947.

Weather observation was resumed in the College on November 20, 1946, following the arrival on the campus of a set of meteorological instruments which were obtained through the courtesy of the Weather Bureau. Mr. Burton Oñate, formerly of that bureau and at that time student assistant in agricultural botany in the College, was the principal weather observer. He was assisted by three volunteer observers, Messrs. Claro Boado, Feliciano Garcia, and Arturo Uichanco, students of the College.

The College has increased its herd of cattle with the purchase of three Nellore cows from the Alabang Stock Farm of the Bureau of Animal Industry.

As a co-operative enterprise with the Bureau of Animal Industry, the College takes care of two bulls of the Bureau, one Red Scindi and one Holstein.

Revised Curriculum

The revised four-year curriculum of the College was approved by the faculty on December 20, 1946, and by the University Council on February 1, 1947. The first two years of this curriculum took effect in June, 1947. The new curriculum prescribes 146 units, excluding military science and physical education, or 10 units less than the old one.

Some features of the new curriculum are: better balance among academic, science, and technical courses; inclusion of *Genetics, Man and Society, Farm Management, Poultry Raising,* and *Bacteriology* in the list of required courses; election of major and minor subjects; and restriction of electives to cultural courses and the humanities. The last two mentioned items are intended to prevent too early specialization at the sacrifice of a broad educational foundation during the undergraduate period. Twenty-one units, including 6 units of thesis are required for the major subject; and 12 units, for the minor.

Among the new elective courses now offered are *Public Speaking,* under the Department of Languages, and *Methods of Extension Teaching* under the Department of Agricultural Education. The latter course is designed to give pre-employment preparation to prospective agricultural extension workers. It is expected to be conducted with the cooperation of the Extension Division of the Bureau of Plant Industry.

The College continues to offer the two-year course leading to the title of Associate in Agriculture and the course leading to the Certificate in Agricultural Education.

The entrance requirements of the University have been slightly modified. In the future, the minimum requirements for entrance will consist of the following: English, 5 units; natural science, such as physics and biology, 2 units; social science, such as history and economics, 2 units; mathematics, 1½ units; electives, 5½ units.

Faculty appointments, promotions, assignments, and resignations

The following members were promoted from associate professor to professor on April 1, 1946: Dr. Francisco M. Fronda, Dr. Anastasio L. Teodoro, and Dr. Valente Villegas.

Assistant Professor Alejandro B. Catambay was appointed associate professor and head of the Department of Agricultural Engineering on April 16,

1947. He took the place of Dr. A. L. Teodoro, who resigned on April 23, 1947, to join the Agricultural Machinery and Equipment Corporation.

Dr. Getulio B. Viado, '35, was appointed assistant professor of entomology in the College. He reported for duty on December 16, 1946.

Assistant Professor Andres P. Aglibut was designated superintendent of construction in the College of Agriculture on November 15, 1946.

Mr. José P. Esguerra was designated assistant farm superintendent in the College on November 15, 1946.

Two members of the faculty were raised to the rank of assistant professor at the November, 1946, meeting of the Board of Regents. They are Mr. Leopoldo J. Villanueva, assistant professor of agricultural chemistry, and Miss Aurora L. Samonte, assistant professor of English.

Mr. Engracio Basio, '31, instructor in animal husbandry and librarian of the College, resigned on April 30, 1947. Miss Samonte was appointed acting librarian on May 13, 1947.

Mr. Albino P. Varona, '29, instructor in the Department of Agricultural Education, was transferred to the Department of Agricultural Economics on April 19, 1947. He took the place of Mr. Marcelo V. Arnaldo, '27, who resigned on May 1, 1947, to accept a position in the Silliman University.

Mr. Vicente M. Dawis, a former instructor in the Department of Agronomy, was reappointed to the same department on June 22, 1946.

Miss Fé K. Villegas, '46, *cum laude*, was appointed assistant instructor in the Department of Agricultural Chemistry on June 5, 1946.

Mr. William L. Fernandez, '46, *magna cum laude*, joined the teaching staff of the Department of Plant Pathology on July 21, 1946.

Mrs. Marcela I. Sevilla, instructor in English, was relieved of her duties in the Rural High School and was assigned to teach collegiate classes in English effective the first semester, 1947-1948.

Miss Nelly Dunglao, B.S.E., *cum laude*, U.P. College of Education, was appointed on June 30, 1947, assistant instructor in English to take the place of Mrs. Sevilla in the Rural High School.

Four new graduates of the College have been appointed assistant instructors, namely: Mr. Simeon M. Alejandro, Department of Agronomy, May 2, 1947; Miss Clare R. Baltazar, Department of Entomology, July 16, 1947; Mr. Burton T. Oñate, Department of Agricultural Engineering, May 2, 1947; and Mr. Filomeno T. Tabayoyong, Department of Soils, May 2, 1947.

Mrs. Juana P. Gapud joined the faculty of the Rural High School on October 7, 1946, as instructor in English. She is the wife of Mr. M. A. Gapud, who joined the College faculty in July, 1946.

Miss Consuelo E. Lipana, '38, B.S.E., College of Education, U.P., was appointed on June 17, 1946, instructor in English in the Rural High School. She resigned on November 8, 1946.

Mr. Gil F. Saguiguit, '47, whose graduation was approved by the Board of Regents on November 9, 1946, was appointed assistant instructor in the College on November 11, 1946.

Mr. Crispin R. Las Marias, '36, was appointed on June 16, 1947, to teach physics and shop work in the Rural High School.

Miss Teresita L. Pronove, a 1947 graduate of the College of Education, U.P., was appointed on July 31, assistant instructor in English in the Rural High School.

Extra-curricular activities of the faculty

Dr. Leon G. Gonzalez, head of the Department of Agronomy, was one of the three members of the Philippine agricultural mission which went to the United States to make a study of the latest agricultural methods and practices. The other two members, Mr. Crucillo and Dr. Sevilla, are from the Department of Agriculture and Commerce. Dr. Gonzalez returned on December 23, 1946, after about four months' stay in the United States.

Dr. Pedro A. David, '19, was acting head of the Department of Agronomy during the absence of Dr. L. G. Gonzalez.

Dean L. B. Uichanco and Dr. F. O. Santos, head of the Department of Agricultural Chemistry, have been designated by President Gonzalez of the University to represent the College of Agriculture in the committee which worked with the agricultural mission from the United States Department of Agriculture. The other members of the committee were Hon. José S. Camus, '14, Mr. Mariano Manas y Cruz, Mr. Francisco G. Galang, '14, Dr. Vicente Ferriols, Dr. Pedro S. Sales, and Dr. Marcos M. Alicante, all of the Department of Agriculture and Commerce.

Dr. Leland E. Call and Dr. John H. Beaumont, chairman and member, respectively, of the American Agricultural Mission, spent several days on the campus as guests of Dean Uichanco. They held conferences with the members of the faculty on the problems of Philippine agriculture.

Dr. Francisco O. Santos, head of the Department of Agricultural Chemistry, and Dr. Valente Villegas, head of the Department of Animal Husbandry, were designated by President Gonzalez representatives to

the Philippine Food and Agriculture Committee. Dr. Santos was also elected first president of the Philippine Association of Nutrition on March 9, 1947. On June 17, 1947, he was appointed consultant in the Bataan Enriched Rice Project by the Secretary of Health and Public Welfare.

Dr. Anastasio L. Teodoro, head of the Department of Agricultural Engineering of this college, was appointed a member of the committee designated by President Gonzalez of the University of the Philippines to prepare a comprehensive list of equipment needed by the University.

At the request of Director Felix Maramba, Assistant Professor Alejandro B. Catambay was detailed to the Bureau of Plant Industry from November 11 to November 16, 1946, to co-operate with the Bureau as consultant in its program of farm mechanization.

Classes and alumni

On May 10, 1946, the faculty of the College approved to recommend the graduation of Telesforo F. Angeles, Abelardo F. Baclig, Rosy R. Baltazar, Dolores P. Barile, Amando O. Boncales, Emerita C. Esguerra, Cresencio T. Garran, Domingo O. Legaspi, Cesar T. Loreto, Cornelio C. Magbanua, Luisa R. Mondoñedo, Rufo H. Ocfemia, Jacinto M. Reduque, Celso G. Santos, Obdulia E. Fronda-Sison, Nathaniel B. Tablante, and Fé K. Villegas.

For the first time in the history of the College, a student graduated *summa cum laude* at the commencement exercises of the University which was held on June 4, 1946. She was Obdulia Fronda-Sison. Three students, Rosy R. Baltazar, Luisa R. Mondoñedo, and Celso R. Santos, graduated *magna cum laude*. Those who graduated *cum laude* were Nathaniel B. Tablante and Fé K. Villegas.

The University Rural High School held its fifteenth commencement exercises on May 2, 1946. Fifteen graduated from the boys' curriculum, with Jorge P. Juliano as valedictorian and Arturo A. Uichanco as salutatorian. Sixteen graduated from the girls' curriculum, with Zoraida J. Sacay as valedictorian and Teresa K. Villegas as salutatorian.

Beginning the school year, 1946-1947, students who had completed six years of elementary schooling and four years of high-school work were required to take a one-year course (common first year) in college before they could take the regular four-year curriculum in agriculture. The subjects in the one-year curriculum are the following: *Introduction to Physical Sciences, Introduction to Biological Sciences, History of Civilization, Mathematics, English, and Educational and Vocational Guidance.*

The school year 1946-1947, opened in College on Wednesday, June 19, 1946, with an enrollment of 253. There were 23 girls in the student body in the first semester.

The Rural High School classes started on June 17, 1946, with 221 students. This was the biggest enrollment in the history of the school. There were 71 girls in the student body.

Examinations for the first semester, 1946-1947, were held on October 21 to 24. Registration was open from November 11 to November 14. Classes began on November 18, 1946.

On November 2, 1946, the faculty approved to recommend the graduation of Jovencio M. Bacalso, Manuel G. Banzon, Jr., Sotero T. Cabañgisan, Floro P. Cangao, Dionisio B. Caday, Lydia V. Catalan, Aquilino D. Dacayo, Lopez M. Garcia, Venancio C. Palis, Gil F. Saguiguit, Alfredo O. Samia, Herminio W. Tantoco, Lamberto J. Tolentino, Manuel A. Velarde, Felix B. Villamayor, and Francisco S. Zamora.

The following senior students who had been called to active duty in the Philippine Army and died in line of duty were graduated posthumously with the degree of Bachelor of Science in Agriculture at the last commencement exercises of the University of the Philippines: Cornelio B. Aglibut, Estanislao B. Cangao, Felix de Castro, Eladio Lawas, Macario Revilleza, Roberto J. Tamisin, and Arnulfo D. Yñiguez.

The College had an enrollment of 220 students in the second semester, 1946-1947. Of this number, seven were new students. There were 15 girls in the student body.

The enrollment in the University Rural High School was 209, of which 66 were girls. Classes started on November 11, 1946.

Twenty-one additional College alumni whose graduation was approved in April, 1947, are the following: Pedro A. Abella, Simeon M. Alejandro, Eduardo A. Artiaga, Clare R. Baltazar (*summa cum laude*), Faustino G. Brual, Juan C. Bunoan, Jr., Leonardo T. Catral, German M. Cruz, Feliciano J. Garcia, Gregorio S. Gascon, Enrique G. Lantican, Ciriaco M. Lawas, Bartolome R. Luardo, José T. Martinez, Alma C. Mendoza, Burton T. Oñate (*cum laude*), Miguel D. Paguio, Primo I. Pizarro, Hilario A. Samonte, Jesús Moran Sison (*magna cum laude*), and Filomeno T. Tabayoyong.

The honor roll released by the Secretary's Office in April, 1947, included twenty-five names. The five highest scholastic averages were attained by Arturo A. Uichanco, Leonardo A. Paulino, Thomas G. Flores, Jesús Moran Sison, and Quirino T. Tagorda.

The 1947 summer session had an attendance of 152 students.

Registration for the first semester of the 1947-1948 school year began on June 9 and ended on June 14. Classes started on June 16, 1947.

The enrollment in the College in the first semester, 1947-1948, was 295, which was 22 more than that of the previous year. The number of new students was 100. The student population is distributed as follows: seniors, 54; juniors, 39; sophomores, 56; freshmen, 142; postgraduate, 2; special, 21.

Classes in the Rural High School started on June 15, 1947, with an attendance of 226 students, of whom 73 were girls. Of this number, 79 were new students.

In a meeting held on June 21, 1947, the College faculty approved to recommend the graduation of Federico L. Labis, Glicerio L. Mercado, and Quirino T. Tagorda. Also approved was the graduation of Ler Chai Chayangkura, of Siam, who finished all the requirements for graduation in June, 1942.

Among the recipients of fellowship grants from the U. S. Department of State for a one-year study in the United States were Messrs. Francisco R. Lopez, '36, José R. Velasco, '40, and Celso G. Santos, '46.

In an interesting letter to Dean Uichanco, Dr. E. B. Copeland, founder and first dean of the College, relates how he helped Mr. José R. Velasco, U. S. State Department pensionado, register at the University of California in Berkeley. Upon knowing that Mr. Velasco came from the College of Agriculture, the dean of the graduate school changed his attitude toward Mr. Velasco's credentials and waived any possible objections by remarking, "Well, that is different; the College of Agriculture has a fine faculty. It is a distinguished faculty."

Mr. Dioscoro L. Umali, '39, of the Department of Agronomy, and Mr. Faustino T. Orillo, '44, of the Department of Plant Pathology, left for the United States on September 1, 1946, as fellows of the University of the Philippines. Mr. Umali will pursue postgraduate work in genetics at Cornell University, and Mr. Orillo will specialize in mycology at Harvard University.

Mr. Nathaniel B. Tablante, '46, assistant instructor in the Department of Agricultural Economics, won the Robert Huffcutt scholarship, which entitles him to take postgraduate courses in agricultural economics at Cornell University, Ithaca, New York.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS AS OF OCTOBER, 1947

No. 2.—Bud Rot of Coconut..... *By G. O. Ocfemia*

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